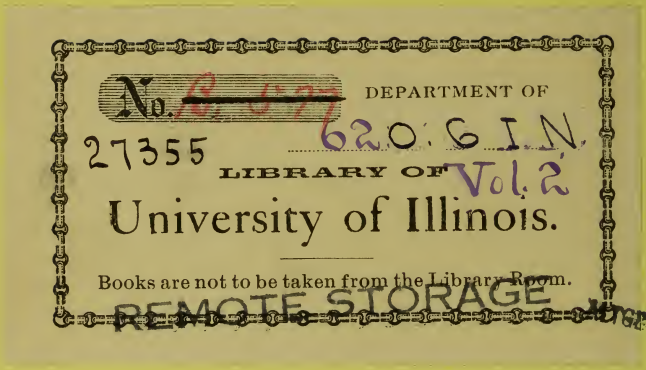
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PROCEEDINGS

OF THE

ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.

VOLUME II.—1874-5.

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REMOTE STORAGE

PREFACE.

The following pages contain the record of the second year's work of the Association of Municipal and Sanitary Engineers and Surveyors. It will not be expected of so young a Society that it should advance any new theory or settle any vexed question; its legitimate work is rather to ventilate existing practice, by affording its members—scattered as they are in official positions throughout the country—the opportunities of meeting to compare notes, discuss principles, and inspect works. The prominent question with the Sanitary Engineer is, of course, the disposal of excreta; the Manchester meeting opened a controversy between the "pail" and the "closet," which, with the practical examples of precipitation and irrigation also inspected and discussed elsewhere, is calculated to dissipate many prejudices and the "one idea" with which officialism is supposed to be associated.

Since the formation of the Association meetings have been held, and works inspected and discussed, in the following towns, some more than once: London, Liverpool, Manchester, Birmingham, Leicester, Barrow-in-Furness, Northampton, Oxford, Reading, Chester, Leamington, Warwick, Tottenham, and Barking. One agreeable feature in connection with these meetings has been the cordial recognition and hospitality shown to the Association by the municipal authorities of the various towns in which they have been held, an evidence that the official functions of the members are better appreciated than heretofore, and that the ratepayer is becoming a convert to Sanitary Science.

L. A.

Town Hall, Stratford, London.

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Worthing	J. Lund.

RULES OF THE ASSOCIATION.

I.—That the Society be named the "ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS."

II.—That the objects of the Association be—

a. The promotion and interchange among its Members of that species of knowledge and practice which falls within the department of an Engineer or Surveyor engaged in the discharge of the duties imposed by the Public Health, Local Government, and other Sanitary Acts.

b. The promotion of the professional interests of the Members.

c. The general promotion of the objects of Sanitary Science.

III.—That the Association consist of Civil Engineers and Surveyors holding permanent appointments under the various Municipal and Sanitary Authorities within the control of the Local Government Board, and such Honorary Members as shall be elected by the Council. Members who retire from their official position are eligible for re-election by the Council.

IV.—That the Affairs of the Association be governed by a Council, consisting of a President, Three Vice-Presidents, Twelve Members, and a Honorary Secretary, to be elected annually. The Past Presidents, and the District Secretaries for the time being, shall also be Members of the Council.

V.—That the Council shall nominate one name for President, six for Vice-Presidents, one for Secretary, and twenty-two Ordinary Members from whom to elect the Council. Such Nominations shall be printed and sent to each Member of the Association not less than thirty days previously to the Annual Meeting. Every Member shall be entitled to vote for or erase any of such Nominations, or substitute other names, subject in all cases to the limits of Rule IV., and return the same within seven days of the date of issue, and the Members who shall obtain a majority of votes shall respectively be duly elected President, Vice-Presidents, Members of Council, and Honorary Secretary for the ensuing year.

VI.—That the Association be formed into District Committees which shall include the whole of the Members. Such Committees shall meet from time to time, in convenient centres, for the discussion of matters of local and general interest connected with the Association. Each District Committee shall appoint a Local Secretary, who will keep records of local proceedings, and communicate with the Council. No District Committee or Local Secretary shall be entitled either to represent or act on behalf of the Association.

VII.—That a General Meeting and Conference of the Association shall be held annually in such Towns, in rotation, as may afford convenient centres for assembling the Members.

VIII.—That an entrance-fee of One Guinea, and a subscription of One Guinea per annum, from Civil Engineers and Surveyors under Rule III., shall constitute Membership of the Association.

SUBSCRIPTION ACCOUNT.

	£	s.	d.
Arrears from last year	9	9	0
Subscriptions due from Members	155	19	6
Admission fees	10	10	0
Subscriptions in advance for 1875-6	6	6	0
	£182	4	6

	£	s.	d.
Received for Arrears	5	5	0
„ Subscriptions	129	14	6
„ Admission Fees	10	10	0
„ Subscriptions in advance	6	6	0
Balance—Arrears due	30	9	0
	£182	4	6

CASH ACCOUNT.

Receipts.

	£	s.	d.
Balance from last year	88	7	8
Arrear Subscriptions	5	5	0
Current „	129	14	6
Advance „	6	6	0
Admission Fees	10	10	0
At Birmingham Meeting	17	6	0
For additional copies of Reports	12	5	0
	£269	14	2

Expenditure.

				£	s.	d.
Home Counties District—Printing and Postages				5	8	9
Midland District—Printing and Postages	£7	4	10			
Expenses of Room for Meeting	1	15	6			
				9	0	4
General Expenses—						
Printing and Stationery	19	4	1			
Advertisements	6	0	6			
Expenses at Birmingham Meeting	37	17	6			
Printing Proceedings	115	1	0			
Stamps	11	16	6			
Secretarial Expenses	10	10	0			
Sundries	2	6	6			
				202	16	1
Balance carried forward				52	9	0
				£269	14	2

I have examined the above Accounts and compared them with the vouchers and receipts, and certify them to be correct, and that the balance in hand at the close of the Subscription year 1875 is £52 9*s*., and that the amount of arrears due is £30 9*s*.

Dated 23*rd February*, 1876.

(Signed) Albert W. Parry, *Auditor*.

ADVERTISEMENT.

The Association is not responsible for the statements or opinions advanced in the Papers and Discussions contained in the following pages.

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ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.

ANNUAL GENERAL MEETING.

MANCHESTER, *July* 1, 2, and 3, 1875.

FIRST DAY'S PROCEEDINGS.

THE Members of the Association assembled at twelve o'clock on Thursday, July 1, in the Mayor's Parlour, Town Hall, Manchester.

Mr. LEWIS ANGELL, M. Inst. C.E., of London, President of the Association, occupied the chair.

The PRESIDENT congratulated the Members of the Association, whom he was glad to meet on the second anniversary of the formation of their Society, they would find that the Association had not lost ground during the past year, but had continued to increase in influence and usefulness.

The PRESIDENT then called upon the Hon. Secretary, Mr. C. Jones, to read the Annual Report of the Council.

REPORT.

The Council have pleasure in reporting the continued success of the Association during the past year.

The publication of the Proceedings, although a costly undertaking considering the limited funds at the disposal of the Association, appears to have given general satisfaction to the members; they have been in demand by the outside public, and copies have been circulated in Canada and America.

The first Annual Meeting and Congress was held at Birmingham, May 28, 29, and 30, 1874, under the presidency of Mr. Angell,

and was well attended by the members and various influential visitors; various important papers were read, as detailed in the published Proceedings.

During the year District Meetings have also been held at Barrow-in-Furness, Tottenham, Coventry, Northampton, and Reading.

The following papers have been read at the District Meetings: "On Street Watering," by Mr. PARRY, of Reading; "The Rise and Progress of Barrow-in-Furness," by Mr. JACOB; "The Sulphate of Alumina (Dr. Anderson's) Sewage Process, by Mr. MELLISS, Engineer of the Company's Works, Coventry; "Northampton and its Sewage," by Mr. PIDCOCK; "The Reading Sewage and Water Works," by Mr. PARRY; "The Average System for determining the Consumption of Gas in Public Street Lamps," by Mr. ELLICE-CLARK.

Visits were also made by the members to the following works: Birmingham Sewage Works; Tottenham Sewage Works; Alexandra Palace (during construction); Coventry Sewage and Water Works; Stevens' Silk Factory, and Wallen's Watch Factory, Coventry; Northampton Sewage Farm; Messrs. Turner's Shoe Factory, Northampton; the Sewage Works and the Water Works, Reading.

The various meetings were well attended, and the discussions upon the papers and works well sustained. The success of these meetings was largely due to the energy and arrangements of the District Secretaries. The Council attach much importance to the District Meetings as the means of maintaining interest in the Association.

The funds of the Association, although small in amount, have proved fully adequate for its requirements, as will be seen by the balance-sheet attached to this Report.*

The question of the election and reconstitution of the Council, and an increased number of Vice-Presidents, has been brought under the consideration of the Council, who have decided to refer the matter for the decision of the Annual Meeting, recommending that the election should be by balloting papers issued to the members before the Annual Meeting.

In accordance with such recommendation a circular and balloting list has been issued, inviting the expression of the feeling of the members, the result being in favour of the following members as officers for the ensuing year: *President*—J. G. LYNDE; *Vice-Presidents*—J. LEMON, G. F. DEACON, E. PRITCHARD; *Ordinary*

* See p. xviii.

Members of Council—F. Ashmead, P. B. Coghlan, A. M. Fowler, J. E. Greatorex, T. W. Grindle, S. Harpur, A. Jacob, P. C. Lockwood, A. W. Morant, E. L. Stephens, T. C. Thorburn, W. S. Till.

In conclusion, the Council desire to impress upon the members the advantages of intercommunication and co-operation, in the various matters connected with their duties, which are afforded by the organisation of the Association, and to urge that its past success should be an inducement for maintaining its permanent efficiency.

Signed, on behalf of the Council,

Lewis Angell, *President.*

The President said it was now for those present to deal with the report as they thought fit. He wished to explain one or two points with regard to the ballot papers sent out. The Council, at the instance of one of their northern Members, had been engaged in considering the system of the election of officers of the Association. It had been represented to them that there was some—he would hardly say dissatisfaction, for no dissatisfaction had yet arisen that he was aware of—but there was some want of unanimity of feeling with regard to the selection of officers. Several methods of election had been proposed, and the Council had recommended for adoption certain alterations in the rules regulating the elections. It was proposed, in the future, to adopt ballot papers, to be sent to all the Members, so as to arrive at their wishes generally throughout the country, and especially of those who were unable to attend the Annual Meeting. The Council had adopted that alteration only to the extent of endeavouring on this occasion to arrive at the feelings of the Members; therefore the result of the ballot was not binding upon the meeting; it was for them to adopt or reject it. The Council had recommended certain names, as in the case of the Institution of Civil Engineers, Royal Institute of British Architects, and other societies. Only a comparatively small number of papers had been returned, but the result of the majority of those who did vote was to place Mr. J. G. Lynde, the City Surveyor of Manchester, in the position of President as nominated by the Council; and supposing the meeting enlarged the number of Vice-Presidents, as proposed, Messrs. J. Lemon (Borough Engineer of Southampton), G. F. Deacon (Borough Engineer of Liverpool), and E. Pritchard (Borough Engineer of Warwick) would be the Vice-Presidents.

Certain names had also been returned for the Council. It was for the Members to adopt or reject the act of the Council and the result of the ballot; but the adoption of the report was a distinct matter from either the proposed alteration of the rules or the election of officers.

Mr. C. Gott (Bradford) moved the adoption of the report as a sufficient and satisfactory statement of what had been done during the past year.

Mr. Parry (Reading) seconded the motion.

Mr. Monson (Acton) asked who had audited the accounts presented this year? He had not audited them, though he had been appointed Auditor at the last Annual Meeting.

Mr. C. Jones (Hon. Sec.) said, Mr. Monson had simply audited the accounts for which he and Mr. Dunscombe had been appointed Auditors. The Auditor for the accounts now presented would be appointed at the present meeting. He did not understand that Mr. Monson and Mr. Dunscombe had been appointed permanent Auditors, and he could not ask Mr. Monson to audit accounts which he had not been appointed to audit.

Mr. Monson said he had thought it was his duty to audit the accounts; and he also thought the accounts for this year should be presented audited. Supposing the Secretary were changed, it would be much better to have the accounts made up.

The Hon. Secretary replied that Mr. Monson could make a proposition to that effect.

Mr. Monson would not make a motion. If the answer was satisfactory to the meeting, it was satisfactory to him.

The President said, he did not think it necessary to take up the time of the meeting with the point. It was very proper to point out that the Accounts of the Association should be well audited, but he thought the Secretary also right in pointing out that Mr. Monson did not happen to be Auditor in the present year.

The motion for the adoption of the report was then put and carried.

The President said, the next point was the proposed alteration in the rules. Was it the pleasure of the meeting to confirm the result of the ballot papers?

The Hon. Secretary said that only sixty-eight papers out of one hundred and sixty sent out had been returned.

The President: Therefore they had the expression of feeling of a little more than a third of the Members. It is for the meeting

to say whether they would adopt that or any other proposal. It was to be distinctly understood that the Council did not, by their proposal, in any way dictate to the Members of the Association the course they should pursue.

A MEMBER thought that more than one name should have been submitted for the office of President.

The HON. SECRETARY: The Council only proposed one name, but any Member was at liberty to propose another.

Mr. THORBURN (Birkenhead) thought that if the affairs of the Association were to be conducted in a proper manner, they should to some extent be guided by the Council, and he thought the Council in this instance had adopted a very proper course. There might be some details on which differences of opinion will arise; but the question now was whether the course the Council had adopted was satisfactory to the Association, and whether Mr. Lynde shall be President. He would propose that Mr. Lynde be President of the Association during the ensuing year.

Mr. TRAPP (Manchester) seconded the motion.

Mr. LEMON (Vice-President) said, this was an irregular proceeding. After Mr. Lynde had been elected by ballot it is absurd to put him up again.

The PRESIDENT explained that the ballot had no force whatever, not being in accordance with existing rules. It was merely an act of the Council, which the Association might adopt or reject as it pleased. If at that meeting they adopted the rule that the officers shall in future be elected by ballot, then the ballot would have the force of law; but at present it is merely an act of the Council for the Members to confirm or reject, as they pleased. Mr. Thorburn's motion was therefore in order.

The motion for the election of Mr. Lynde to the office of President was then put and carried unanimously.

Mr. ANGELL, the retiring President, addressed Mr. Lynde, the newly-elected President, as follows: The Association has this day unanimously elected you to the office of President. It is an office to which the Association attaches some importance, because it is the greatest honour it can confer on any of its Members, and I am sure it could not confer it on a more worthy Member than yourself. I now vacate the chair with a grateful recollection of the support I have received, and the honour the Association has done me, and I am sure I give place to a worthy successor, and that you will not allow the interests of the Association to suffer in your hands.

Mr. Angell then vacated the chair, which was taken by Mr. J. G. Lynde, M. Inst. C.E., City Surveyor of Manchester, as President of the Association for the ensuing year.

Mr. Monson (Acton) proposed Mr. Thorburn as one of the Vice-Presidents for the ensuing year. Mr. Thorburn occupied a position in one of our chief towns, and he (Mr. Monson) thought Mr. Thorburn a very proper man for the office. He objected to the ballot, and proposed to throw it overboard altogether.

Mr. Trapp (Manchester), if it were in order, to make matters short, would move that the ballot sent in to the Council should be adopted as regards the Vice-Presidents.

Mr. D. Davey (Maidenhead) seconded Mr. Trapp's motion, as he thought the Council had given the matter very serious consideration, and had acted for the best.

Mr. Thorburn said, it would be remembered that last year he made a proposition that there should be two Vice-Presidents, and the working of the Association had not in the least altered his opinion on that point. He did not want to raise any factious opposition, but there ought to be among their officers those holding positions of influence in different parts of the kingdom. It was true that by the election, so far as it had gone that morning, the Association would be represented by its principal officers in the north and south; but that was not sufficient. Last year he proposed that there should be two Vice-Presidents, and he understood that that morning a proposition had been put forward to confine the Vice-Presidents to one, on the ground that increasing the number would lower the dignity of the office. To some extent that was true, but the question was not one of dignity but of usefulness. There had been another proposition that there ought to be a Vice-President in every district, but he was inclined to think that two would be sufficient for all practical purposes.

The President (Mr. Lynde) said, he must rule that Mr. Thorburn was out of order. It had been already agreed on that the election of officers should precede the proposed alteration in the rules, and the carrying out of that arrangement had been already commenced. The President had already been elected, and the other officers must be elected in accordance with the rules as they stood. The Association could afterwards entertain any proposals for the alteration of the rules.

Mr. Thorburn, with all deference, claimed to be in order, inasmuch as the resolutions of the Council had not yet been adopted.

The Council recommend the appointment of three Vice-Presidents, and that is what he was speaking to.

The PRESIDENT: But they were proceeding now under the existing rules.

Mr. RICHARDSON (Tranmere) said, the ballot papers sent out by the Council were for the election of three Vice-Presidents, and to that Mr. Thorburn was speaking.

Mr. THORBURN said, he had not the slightest objection to move that the number of Vice-Presidents should be three.

The PRESIDENT: Are you going to move that?

Mr. THORBURN would be content with two Vice-Presidents; but it was not because they gave him more than he asked that he objected. He thought it would be an encouragement to form districts, and would tend to the good working and supporting of the interests of the Association over the kingdom if there was a Vice-President for each district.

The PRESIDENT inquired if Mr. Thorburn would move the election of three Vice-Presidents for the following year, to which Mr. Thorburn assented.

Mr. MONSON seconded the motion.

Mr. JACOB (Barrow-in-Furness) said, the question was whether the Association would have three Vice-Presidents or one. The Council had acceded to some wishes that had been expressed that the number of Vice-Presidents should be extended to three, and Mr. Thorburn's proposal went so far as to say that those three Vice-Presidents should represent respectively three districts. Now, he did not know how the Association at large would be able to elect three men, each of whom would be a representative man in his own district. Until that was explained he did not see his way to supporting the motion for the appointment of three Vice-Presidents.

The President having put the resolution that the number of Vice-Presidents should be three, it was declared carried.

Mr. ANGELL (Past President) moved that the three gentlemen whose names stood highest on the balloting list, namely, Messrs. Lemon, Deacon, and Pritchard, should be the Vice-Presidents for the ensuing year. Following the precedent of the President's election, he thought the meeting could not do better than accept those three gentlemen as Vice-Presidents.

Mr. THORBURN seconded the motion, which was carried.

The PRESIDENT said, the next business was the election of a

Council. The first question would be, how many Members the Council was to consist of? There were sixteen names on the balloting list, and the Association would first consider whether sixteen should be the number.

Mr. Angell (Past President) said, he had been for some time of opinion that the Council was too large, for different Members attended on different occasions. Considering that the Association numbered altogether only about one hundred and sixty Members, he would propose that the Council be reduced to twelve. It should be remembered that four district Secretaries were *ex-officio* Members, and they now had three Vice-Presidents and a President, who were also Members of Council, and he supposed some place would be found for himself, as Past President. With so many *ex-officio* Members, he thought twelve ordinary Members would be sufficient. He therefore proposed that the number of elected Members should be limited to twelve, and that those be the twelve highest on the balloting list.

Mr. Pritchard (Vice-President) seconded the motion. From his experience as a Member of the Council, he thought they might look forward to twelve working much better than sixteen, and up to the present there had been no difficulty in obtaining a quorum of Members to act. He might state that he did not know what names were on the balloting list, and he had not therefore the slightest personal bias.

The Hon. Secretary read the names of the sixteen gentlemen highest on the balloting list.

Mr. Vawser (Warrington) proposed that the rules should be altered, so that all Past Presidents should be Members of the Council; if that were not done, the Association would lose the services of Mr. Angell, and those who would follow him, gentlemen who would necessarily be best up on all matters that might come on for discussion.

Mr. Angell's motion that the first twelve Members whose names were highest on the ballot list should, with the *ex-officio* Members, form the Council was adopted.

Mr. Vawser's proposal that Past Presidents should be *ex-officio* Members of Council was also seconded and adopted.

Mr. Pritchard (Vice-President) said, he had great pleasure in proposing that Mr. C. Jones, the present hard-working and energetic Secretary, to whom the Association was very much indebted for his past services, should be Secretary for the ensuing year. He was

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fully persuaded that that proposition would be supported by every Member of the Association.

Mr. Lobley (Hanley) seconded the motion, and said that Mr. Jones had worked very hard for the Association from the beginning.

Mr. C. Jones was unanimously re-elected Hon. Secretary.

Mr. C. Jones, in reply, said he had to thank the Association for the honour they had again conferred upon him. There was a certain quantity of work to do, and he hoped he would do it in future as he had done in the past.

Mr. Ashmead (Bristol) proposed, and Mr. Jacob (Barrow-in-Furness) seconded, that Mr. Parry (of Reading) and Mr. Davey (of Maidenhead) should be appointed Auditors for the accounts of the past year.

Mr. Fowler (Salford) said, he had a proposal to make in respect to the secretaryship. He thought it was very unkind to rely on Mr. Jones to do all the work in connection with the Association. He had been much struck lately with the large amount of work that Mr. Jones had to perform in connection with the Association, and they all knew that a man in the position of a Borough Surveyor had quite enough to do to attend to his own business without spending his time with all the routine work of the Association. Some one should be appointed to assist him, and he (Mr. Fowler) would, therefore, propose that the question of appointing an Assistant Secretary should be referred to the serious consideration of the Council.

Mr. Thorburn seconded the motion, which was carried.

Mr. Lemon (Vice-President) said, he had now a motion to make. He had had the pleasure when the Society was in its infancy of proposing Mr. Angell as President, and time had shown that he had proposed the right man in the right place. Mr. Angell had done an immense amount of work, and the way in which he had edited their Proceedings reflected great credit on the Association. The Proceedings had been presented in a most creditable manner, and everyone who had seen them passed high encomiums upon them. It was a work which Mr. Angell had volunteered to do in addition to the various other duties which he had performed as President. He proposed that the thanks of the Association should be accorded to Mr. Angell, the Past President, and that the vote should be recorded on the minutes.

Mr. Ashmead (Bristol) said, he had great pleasure in seconding

the resolution; in fact, the Society owed its existence to Mr. Angell.

The motion was put and carried by acclamation.

Mr. Angell, in reply, said: I thank you very much for your very kind expression of thanks in recognition of my services. I have been connected with the Association, and at the head of its affairs, from the very commencement, and you can easily imagine that I have watched its progress with very great interest. I am very much pleased indeed to think that I can hand it over in its present flourishing condition to my successor, Mr. Lynde, who will, I have no doubt, continue to promote our objects. Mr. Lemon has referred to the Proceedings which I had the pleasure of editing; speaking of the matter contained in them, I think the papers and discussions do no discredit to the Association, and I shall be pleased, if it be your wish, to continue to edit the Proceedings. I hope we are now beginning a long and flourishing career. We have already taken our position among the societies of the day, and I thank you very much, gentlemen, for your kind recognition of the part I have taken in the affairs of the Association.

The President then stated that the proposed alteration of rules was the next business.

Mr. Jones (Hon. Secretary) suggested that it would be wise to leave this question to the Council to arrange, in accordance with the expression of opinion that had been given that day. A discussion upon the alteration of rules would probably last some time, and cause them to trench upon the time allotted to the papers.

Mr. Thorburn (Birkenhead) moved that the rule regulating the election of officers and Council be altered so as to be in conformity with the proceedings of that morning.

The Hon. Secretary suggested that the ballot papers be sent out for the election two months before the annual meeting, and that the Council receive such ballot papers and report the result to the annual meeting.

The motion in the form suggested by the Hon. Secretary was passed.

Mr. Angell (Past President) moved that existing Members of the Association should be allowed to continue Members, independently of changes of appointment, so long as they continued to pay their subscriptions. He supposed they would not be eligible as Members of Council unless they held an official appointment.

Mr. Ellice-Clark (Ramsgate) seconded the motion. In his

district there were two Members who had taken great interest in the Association, but who had now metropolitan appointments; under the existing rules they were not eligible to continue Members, although they were most anxious to do so.

Mr. THORBURN proposed that the matter should be referred to the Council.

Mr. LEMON (Vice-President) thought that gentlemen vacating their municipal appointments should be eligble for re-election as Members. If Mr. Lynde or Mr. Angell vacated their appointments, would the Association say that they should not continue Members? Even if they did not hold municipal appointments, they had shown that their sympathies were with the Society, and they ought to be continued as Members as long as they wished to remain.

Mr. DEACON (Liverpool) said, he would propose an amendment to the effect that a Member retiring from the municipal position which he held would lose his position as a Member of the Society, but would be eligible for re-election. It might happen that a municipal officer might retire from his position under such circumstances that the Association would not desire that he should continue a Member.

Mr. THORBURN said the Association might get over the difficulty by leaving the matter to the Council to recommend a retiring Member to the Association for re-election.

On the motion of Mr. DEACON, seconded by Mr. THORBURN, it was resolved that a Member retiring from his official position would be eligible for re-election by the Council.

The HON. SECRETARY said the Association would have to fix the next place of meeting. The matter had been considered by the Council, and the opinion among them seemed to be that the next annual meeting should be held in London.

Mr. PRITCHARD (Vice-President) proposed that the next annual meeting should be held in London. They had already held their annual meetings in the two great centres of the midland counties and the north, and he thought their third meeting should be held in the great centre of the south.

The motion for holding the next meeting in London was passed, and it was left to the Council to fix the time.

THE PRESIDENT'S ADDRESS.

The PRESIDENT then delivered his Address, in which he said he had to thank the Association very much for the honour they had conferred upon him in electing him their President for the ensuing year. He assured them he felt a deep interest in the continued success of their Association, and nothing should be wanting on his part, so far as he was able, in forwarding its objects. It would, he was aware, be a difficult task to follow in the steps of their friend Mr. Angell, the founder of the Association, who had so ably filled the office of President for the last two years, and had, by his energy and perseverance, during that short period been the means of developing within them a power that would, he trusted, be a valuable means of advancing sanitary science. The success of their Association (recognized as it is by all the leading municipal authorities in the country) must be a matter of congratulation amongst themselves, and he hoped they would all do their best to maintain the position which their Association had attained; for they must bear in mind that it was only by united action that they could continue to be useful in their joint capacity. When they considered the elements of which the Association was composed, and the great variety of duties its Members were called upon to perform, they must of necessity accumulate a vast amount of experience, which, when brought together, would be of great value, and the making of this experience available to all the Members, he took it to be one of the principal objects of the Association. The works they were called upon to design and execute brought into play all the powers of the civil and mechanical Engineer, and he could confidently state that no person was qualified to undertake the office of Surveyor to a municipal or sanitary authority who had not had the education of an Engineer. The works he is called upon to construct comprised road making, bridge building, sewerage, waterworks, gasworks, the improvement of river courses, and such-like engineering works. He must also possess a sufficient knowledge of architecture to enable him to design a respectable-looking building, such as a police station, market, or perhaps a townhall. He might also be called upon at any moment

to decide at once on the safety or otherwise of a building where the lives of the public are in his hands, and the exercise of this duty required the greatest circumspection, as he might on the one hand needlessly destroy property, and on the other sacrifice life. He must also acquire a knowledge of the value of property, in order that he might be able to advise as to the cost of street improvements. Some of the Members appeared to think that the duties of the Surveyor also included many of those which strictly belonged to the medical officer of health, and there was no use in disguising the fact that a considerable amount of jealousy existed in many places between those officers. There could be no doubt that, in order to arrive at the most satisfactory results, there should be perfect unity of purpose and action between the two, and the best way to arrive at this would be to have a clear understanding as to the duties of each department. In his opinion, the medical officer of health should confine himself to defining the principles which he considers the best calculated for dealing with all matters relating to the public health; and when the carrying out of those principles does not involve engineering or structural work, his recommendations should be carried out entirely under his own direction; but where structural works are required, their object should be clearly defined by the medical officer, and the works should then be designed and executed by the Engineer or Surveyor. If they took, for instance, the mode of dealing with sewage and house refuse, it was for the medical officer to point out the system which in his particular case he considered the most suitable, and for the Engineer to design such works as might be best calculated to carry out the views of the medical officer. It was not for the Engineer or Surveyor (although he might and ought to have a general knowledge of chemistry) to interfere with the principles affecting the death-rate, or to make himself responsible in any way respecting it, beyond the proper execution of those works which might be necessary and proper for carrying out most effectively the principles laid down by the medical officer of health. He believed if some such course were adopted it would ensure that unity of action between the two departments which is of vital importance to the interests of the ratepayers. With regard to the much-vexed question of Government protection, he was strongly in favour of local self-government, and the Surveyor being the officer of the local authority should, in his opinion, endeavour to work cordially with its members, rather than seek to be under the influence and protection of any central autho-

rity, to be used perhaps as a means of coercing the local authority. The duty of the Surveyor is to carry out the instructions of the local authority; and if such instructions are not in accordance with the views of the central authority, let the two governing bodies settle their differences between themselves. With regard to the personal question that had been so strongly urged as a reason for Government protection, he was sure if a Surveyor discharged his duties courteously and firmly, he need be no respecter of persons, as he would always be sure of the public support if any undue influence were attempted to be brought to bear upon him. Many of them were aware that those had been his opinions from the first, and that he refused to join the Association when its principal object appeared to be the obtaining of Government protection in the performance of their duties. They must not suppose for a moment that he undervalued the importance of a central authority; on the contrary, he considered it most useful as a guide and assistance to the local authority, especially in matters which applied to the whole country alike. It ensured a certain amount of uniformity of action, without which municipal legislation would become a mass of inextricable confusion. He might take this opportunity of expressing his gratification on the production of their first volume of the Proceedings, which contained so much valuable and useful information. It did great credit to their Past President, who so ably edited it, and to those gentlemen who had assisted in its preparation. It is a volume of which the Association may well be proud. Again thanking them for the honour they had conferred upon him, he would now take his seat as their President for the ensuing year, in the confidence that he should receive from them that assistance and support that would alone enable him to discharge satisfactorily the duties of the honourable position in which they had placed him.

Mr. Angell (Past President), in proposing a vote of thanks to the President for his address, said there was one question on which he entirely differed from the President, and that was on the subject of Government protection. In a great city like Manchester, influenced and governed by great men of large views, the experience of the public officials was totally different from that of officials elsewhere. No one could have greater respect for local government than he (Mr. Angell) had, but he knew from experience, and he knew from report, and they all knew, the littleness

by which local government was sometimes governed. In the smaller towns, and they formed the great majority of the towns of the country, it was notoriously impossible for a man to maintain his position with that firmness and independence to which the President had referred. Local Surveyors had asked loudly for protection.

Mr. Fowler (Salford) rose to order. Was it open to discuss the President's address ?

Mr. Angell said, he ought perhaps to have contented himself with a simple expression of opinion; but as the fundamental principle upon which the Association was founded, was that it should maintain the position of its Members, he could not allow the President's views on this point to pass without his expression of dissent; he would, however, conclude by proposing the thanks of the Association to the President for his address.

Mr. Lemon (Vice-President) said, he could not strike his flag in reference to protection. He had always advocated it, and always would do so; not because he wanted it himself; he was egotistical enough to think that he did not—but he knew many of his brother Surveyors who did want it seriously. He knew a case in which a Surveyor had to report on a building application, and there were three gentlemen on the committee, one of whom was the owner of the ground, another was a timber-merchant, and the third was a builder, and all of them were interested in the matter. The Surveyor reported that the buildings were not in accordance with the bye-laws, and could not be erected; but the committee decided that they were in accordance with the bye-laws, and they told the Surveyor that if he did not carry out their decision they would dismiss him. If protection was not required in a case like that, he would like to know where it was required. There was another point, not in reference to the pressure put on by members of council, but to the pressure put on the members of council by the ratepayers. The members often vote against their own convictions through the influence of the ratepayers, and think they are only doing their duty in representing the views of those who sent them to the council, and however erroneous those views might be, they would support them. It was therefore very important that the Surveyors should have some protection. As regarded the medical officers—he was not treading on a sore point now—he thought it extremely desirable that there should be a thorough concord between the medical officers and the Surveyors, and he thought

some better understanding was wanted than existed at present. In his borough the medical officer was a most amiable gentleman, and he worked most cordially with him; but in many cases the medical officer could not stir a peg without coming to him. When a notice was served on a person by the medical officer, and a question of building construction arose, the medical officer came to him to know how it was to be carried out. It was very necessary that the duties of the two officers should be clearly defined. He seconded the vote of thanks to the President for his address.

The vote of thanks was put by Mr. Angell, the Past President, and carried.

The ordinary business of the meeting having concluded, the members adjourned until two o'clock, for the reading and discussion of papers.

SANITARY CONFERENCE.

The Meeting was attended by several persons of influence in the District, including the Mayor, Sir Joseph Heron, Medical Officers of Health, Members of the Corporation, &c.

The President (Mr. J. G. Lynde), in opening the proceedings, said, in opening that conference he could not help expressing his gratification—and he was sure all the Members would join him in doing so—at the interest the municipal authorities throughout the country took in their proceedings. He might mention particularly the Mayors of Manchester and Salford, who had both expressed themselves strongly in favour of the Association, and he had to express the thanks of the Association to the Mayor of Manchester, then present, for the facilities he had so kindly afforded them in granting them the use of his Parlour for holding their meeting. He had seen the Mayor of Salford on the previous day, and he expressed his regret that he was unable to be present on that occasion, being obliged to be in London that day on municipal business. They had also the pleasure of having with them that day the Chairman of the Health Committee, Mr. Councillor Schofield, and other members of both Corporations, who took special interest in sanitary matters. He was also pleased to see Sir Joseph Heron, the Town Clerk, who had, he believed, devoted more time to sanitary legislation than anyone else, and he hoped he would oblige them with a few remarks on that very important subject. He was also glad to see the Medical Officer of Health for the City. His friend Dr. Leigh, the Medical Officer of Health for Manchester, who had made the dealing with house refuse his special study, had kindly promised to describe to them his experimental works in Water Street, and to show them there the result of his labours. Several other gentlemen, both Members of the Association and visitors, had kindly promised, them some papers, upon which much interesting discussion would no doubt take place. Their Past President, Mr. Angell, would give them a review of sanitary progress, and if he could only show that they were advancing surely, if slowly, in the right direction, it would be very satisfactory. They would no doubt have the much-vexed

sewage question brought forward in connection with Mr. Angell's paper, and with that of Major-General Scott; and Mr. Fowler, the Borough Engineer of Salford, had promised to describe a cottage water-closet that was self-acting, and was said to require no water beyond what may have been used for washing or culinary purposes. This had now been in operation for some time in Salford, and professed to get over the difficulty of the increased supply of water required for the introduction of the water-closet system into cottages; but the advocates of the dry system would tell them that this was not the only difficulty to be overcome, nor was it in their opinion the most important. But there were other subjects of interest to the municipal Engineer besides the sewage question to which they must devote their attention. The paving of streets was one which was of great importance to the ratepayers, and one which must be continually before them in their daily work. Although they had no paper on their programme directly relating to it, they were promised two papers on the machinery in use for preparing stones for roads; one on a stone-breaking machine, by Mr. Jacob, of Barrow-in-Furness; and the other a description of a stone-dressing machine, by Mr. Royle, of Hulme. They had in Manchester the reputation of having the best street pavement in the country, which he believed to be attributed to the great care they took in forming a solid and uniform foundation, and that they did without making use of concrete. They had not yet cut up their streets with tramways, but they were about to do so, and he hoped in a manner that would obviate the great objection to their use, namely, the formation of a rut or groove by the side of the trams that was so injurious to the wheels of private carriages; for if this could not be done they would, in his opinion, be better without them; but if they succeeded in doing this—and he believed it was quite practicable—they would, in his opinion, be of immense advantage to the traffic, and would lessen very much the cost of maintaining our roads. Whether the wood pavement lately laid down in London would turn out to be an improvement on our system remains to be proved; it certainly formed a very good surface, and was far more pleasant to ride over than granite sets; but there were doubts in his mind as to the healthiness of it on account of its power of absorption, and it might not, after all, on that ground, be desirable, even should it be successful on the score of comfort and economy. They were also to have a paper by Mr. Vawser, of Warrington, one of their local Honorary Secretaries, on another

very important subject, and one which had lately engrossed much attention, the construction of artisans' and labourers' dwellings. That was one of the most important questions of the day, inasmuch as it bears directly upon both the moral and physical improvement of the working classes; it must also be one of the principal means of reducing the death-rate, upon which Mr. Ellice-Clark, of Derby, would read them a paper. They were also promised papers by Mr. Councillor Bailey, of Salford; Mr. Goodhall, and Mr. Elcock, who were not Members of the Association; and he had to thank them and other visitors for their attendance there that day. The papers they promised were each of them on subjects of great interest to all of them. With such a programme before them, he thought they would all agree with him that it would be necessary to restrict the time allowed to each speaker to ten minutes, in order as far as possible to allow everyone interested in a subject an opportunity of addressing the meeting. Under those circumstances he would not now occupy more of their time, but call upon their Past President, Mr. Angell, to read his paper. Before resuming his seat he might state—and he hoped it would be clearly understood—that the Association was not, as a body, responsible for the statements that might be made, or the opinions that might be expressed, at their meetings.

Mr. Angell, whose name was on the programme to read a paper, "A Review of Sanitary Progress," said that a combination of circumstances had prevented him from bringing forward his paper that day, but as there were so many papers down for reading his could very well be dispensed with. He hoped, therefore, that they would excuse his paper. Recently, and during the present session of Parliament, great attention had been paid to sanitary matters, and he hoped to see great improvements and great facilities given to sanitary authorities to carry out sanitary matters.

The following papers were then read:

THE DISPOSAL OF EXCRETA IN MANCHESTER.

By Dr. LEIGH, Medical Officer of Health.

Dr. Leigh said, he had not prepared a paper, but he would give a brief outline of what had been done in Manchester in regard to the treatment of the excreta and refuse of the city. A few years ago, when he was appointed officer of health, and the health committee of the corporation was formed, they found that from fever, under the forms of typhus and typhoid, there were about 630 deaths in the year in Manchester. That was a very high mortality, and on investigating the condition of the city they found that there were attached to the houses a number of cesspools, which, if the aggregate area covered by them were measured, would make a lake about sixteen acres in extent, and four or five feet deep. That was an amount of putrefying, decomposing matter which, by its very presence, vitiated the atmosphere very much, and contributed largely to the forms of zymotic disease which he had mentioned. They likewise found that a large portion of the inhabitants of Manchester was resident in cellars, which were damp, dark, dismal, and uninhabitable. They applied themselves, first of all, to the provision of hospital accommodation for the reception of cases of infectious disease, with the view, in the first instance, of checking the spread of it, because they were quite satisfied that whatever they did towards lessening the tendency to the disease and diminishing the existing causes of it, inasmuch as those diseases were everywhere infectious, it was desirable to stop the spread of them by providing hospital accommodation, in order to isolate the cases. The result of the efforts made was that a large hospital for the purpose had been provided in the neighbourhood of Manchester, and a large children's hospital had also been erected, he believed, partly in consequence of the efforts of the health committee. Then the sanitary authorities applied themselves to checking the amount of putrefied matter eliminated into the atmosphere by the decomposition of the excreta lying for

months together in a liquid state in the cesspools. The first discovery they made was, that however much inclined they might be to the water-carriage system, and however applicable it might be where an abundance of water was obtained, such a supply of water was not available. However, if it had been, the water-carriage system would not necessarily have been adopted in Manchester. The sanitary authorities abolished the cesspools in the first instance. They emptied them out, and the earth that was saturated with the excreta was removed, and the cavities thus made were filled up, and dry closets built over them. Those dry closets were of very simple construction. They had receptacles of galvanized iron, with square wooden boxes placed at the back to receive the refuse of the houses. There were constructed in Manchester about fifteen thousand of them. Each closet was furnished with a flue. As to the utility of those flues there had been a great deal of dispute, but the experiments made showed that the closets were rendered much sweeter by them. The excreta were now removed once or twice a week. The cinder-sifting apparatus used in Manchester was self-acting. The cinders and ashes were thrown apart, and the fine ashes fell through the perforated surface on to an inclined plane, from whence they fell on the excreta, and formed an excellent deodorizer. The cinders rolled over the perforated plate, and fell into a box, from whence they were taken for fuel again. There was considerable economy in the use of the apparatus. He had fixed one in his own house, and he believed that in about a month it saved its cost in coal. People who used it told him that the cinders they got from it served their boilers and washhouses better than coal. As he had said, the contents of the closets were removed once or twice a week to the yard in Water Street, in carts constructed for the purpose. The carts which brought the street and house refuse were emptied into the yard, and the corporation got a certain payment per week from the men who were allowed to take away the rubbish. Those who took away the old cans, iron pots, &c., gave 25*s.* a ton for them. They were chiefly used for making copperas. Then the old boots and shoes and woollen cloths were also separated from the other rubbish, and for these the corporation received 25*s.* per ton. He believed those were extensively used in the manufacture of Prussian potash. Then there remained nothing but the fine ashes, cinders, broken clay pots, broken glass, and that kind of thing. The remaining matter was thrown upon a sieve, which was worked by machinery, and the fine ashes

having passed through, the other stuff was mixed with lime, and being thrown into a mortar mill, made excellent mortar. The fine ashes were put into an apparatus which had been constructed for the manufacture of manure, and mixed with about 20 per cent. of slaughter-house refuse. It was ground up until it became a pulp. They also got all the stale fish of the city, and a large quantity of other animal matter mixed up with the manure. A calculated quantity of sulphate of lime was also mixed with the other materials. The ammonia which would be given off was thus gradually taken up. He was quite aware that sulphuric acid had been used for the manufacture of manure, but that had been a mistake. The manure therefore consisted of solid and and liquid excreta. The fine ashes, slaughter-house refuse, and other animal matter were mixed up, and the gentleman connected with the manufactures said the deodorizing power of the mixture of fine ashes and sulphate of lime was exceedingly great, and exceeded that of charcoal. The effects of the manure appeared to be very considerable. He had had an opportunity within the last three weeks of visiting two very extensive farms on which it had been employed. One had taken up 400 tons of it, and the other 100 tons. The crops were very remarkable indeed. One crop, which consisted chiefly of the finer kind of grass and clover, was not less than $2\frac{1}{2}$ tons to the acre; and another crop amounted to 3 tons to the acre. The farmer stated that he had never before had such crops in his life. If the expectations of the authorities were realized, and he saw no reason why they should not be, they would be able to work this stuff not only without loss, but with a considerable profit. He thought they would be able to manage 2000 tons per week for manure, at 12*s.* 6*d.* per ton. For the mortar they received 4*s.* 6*d.* or 5*s.* per ton, and for the scrap iron 25*s.* No matter what came into the yard, nothing was sold at less than 4*s.* 6*d.* a ton. Then the sanitary results were highly satisfactory, for all forms of fever were gradually diminishing in number. In the first year in which they began to empty the smaller cellars the fever cases were reduced to about 520, and before the work was begun the number in the year was 628. In the next year they decreased to 480, and last year to 180. This year he did not think they would be more than 120. Small-pox set in in Manchester at the time of the great epedemic with as much severity as in any town in England, and yet though the deaths reached as much as 70 per thousand in some towns in England—and the lowest in any town, except Manchester, was

20 per thousand—in Manchester the proportion was only 7 per thousand. They were gradually getting rid of fever in Manchester, and there was very little fever in the city now. The mode of disinfecting in Manchester had been very thorough. The necessity for disinfection had begun early to press itself upon their attention. They constructed a large disinfecting oven, and the clothes of infected persons, carpets, curtains, and bedding, and, in fact, all articles of drapery were taken to this oven, and unless they were of a character that might be destroyed by the process, they were subjected to a temperature of 230 or 260 degrees. On examining the houses in which scarlet fever and typhoid broke out, he found in many of them a great thickness of paper on the walls. In many cases he removed sixteen coats of paper. Of course matter like that would hold the poison a long time. Now, consequently, in disinfecting the houses they stripped the walls of all the paper, and washed the plaster with a strong disinfecting solution, and they scattered chlorine about abundantly. The effect had been in every way satisfactory. It was curious to observe, that although the disinfectors, whose special duty it was to disinfect the articles of clothing and furniture, were comparatively free from attacks of infectious disease, the men who stripped the walls were all attacked. That showed how thoroughly paper held this matter. He believed the system of disinfection used in Manchester was thorough, and it never happened that the disease again broke out in a house after it had been disinfected.

DESCRIPTION OF SELF-ACTING WATER-CLOSETS AS CONSTRUCTED IN SALFORD.

By A. M. FOWLER, M. Inst. C.E., Borough Engineer, Salford.

The removal of refuse from cottage property having become such a serious question, I have been induced to devise a means whereby the most objectionable part of it can be removed from the premises as quickly as possible, believing that the storage of filth in any receptacle, if only for a day, is likely to be attended with serious results. As yet, no profit has been made of it. If collected, there is no justification for depositing the privy refuse in the midst of a thickly populated town. The values of town refuse as set forth by enthusiastic adventurers have not been realized by manufacturing. Large fortunes have been lost after the most promising prospectuses have been issued. No doubt, there is some value in the refuse, but such value is principally contained in the urine where the ammonia is present, but the expense is so great in getting at it that it is not worth the trouble. This liquid cannot conveniently be collected, therefore it is passed off into the sewers. The manual labour required to remove the refuse, the constant attention required to empty the receptacles, the cart hire and storage of the material (very often in the midst of a thickly-populated district) are not satisfactory and cannot possibly be remunerative. The removal of the refuse alone will cost, taking a very low estimate, not less than 7*s.* 6*d.* per ton, and will exceed this if carted from the midst of the population. It is not my intention to point out the defects of the *many methods* in use, but rather to show the advantages of the one I propose, leaving the public to judge. The question is one in which every individual should be deeply interested. Twenty-five years' experience in the sewage of towns has enabled me to notice the working of the many schemes which have been, and are now before the public. I am convinced the first object to be obtained is to secure the removal of the fæcal matter from the premises as quickly as possible, and so prevent fermentation and the generation of foul gases.

It cannot be denied that the water-closet system accomplishes this object in the most complete manner. This system would, I have no doubt, be universally adopted but for the cost of towns water and the application of machinery.

The removal of the excreta by means of the earth-closet, cinder-sifter system, or other such contrivance, does not relieve the sewers of the whole of the human excrements, or get rid of the most objectionable part of it.

This is clearly borne out in the Report of the Rivers Pollution Commission, vol. i. 1870, p. 30:

"The retention of solid excrements in middens is not, therefore, *attended with any considerable diminution in the strength of the sewage*, although the volume even in manufacturing towns is somewhat reduced; neither is the case substantially different when earth-closets are substituted for the Lancashire midden, for the sewage from Broadmore Lunatic Asylum, in which these closets are partially used, exhibits no exceptional degree of weakness. . . . . It seems hopeless, therefore, to anticipate any substantial reduction of sewage pollution by dealing with solid excrementitious matters only."

I am convinced, wherever manual labour is resorted to for collecting the fæcal matter for the storage of the same in receptacles, or at a dépôt in a town, the work is attended with foul stench and serious results, especially when stored in populated districts.

Should the material be carted out of the town the expense would be more than the ratepayers could bear. The method of collecting the excreta in tubs does not interfere with works necessary to deal with the sewage and slop water passing from houses into the sewers. Such water must be passed off into our rivers or the sea, so as not to create a nuisance; therefore, to deal with the sewage from large towns extensive works must be resorted to, either by acquiring large tracts of land to utilize the sewage by irrigation, or in the event of land not being situated at a convenient distance so as to bring the same within reach, works for deodorizing the sewage by means of precipitation must be erected.

With these views I have prepared a design for the construction of water-closets on such a plan that the use of towns water and the application of machinery are dispensed with.

The water-closet I propose is formed by fixing a siphon-pan under the seat of the closet, at such a level that the slop and waste water from the sink and the slops from the rooms of the house (to

the slopstone in the yard), and the rain water from part of the roof of the buildings, are diverted by a covered drain into the siphon-pan, which is lengthened from the underside of the seat of the closet to suit the level of the drain from a trapped gully in the yard.

The advantages accruing from this system are:

1st. The disgusting manual labour of emptying privies or tubs, carting the tubs through the town, and storing the filth in the midst of the inhabitants, is dispensed with.

2nd. Saving in cost of labour in emptying receptacles, cart hire, rent of dépôt, stables, all labour in connection with the storing of filth, and the wear and tear of plant and materials.

3rd. The stench from time to time arising from the tubs or privies near the house will no longer exist.

4th. The ashes as stored by my system do not create the slightest nuisance, and may be used for works in making foundations for streets, filling up excavations, or otherwise in the town. Garbage tubs may be used.

5th. Towns water is not needed, the refuse water from the house being considerably more than absolutely required, and more than is usually passed through an ordinary water-closet supplied with towns water.

6th. The closet is always free from smell, sulphurated hydrogen not being present, as is the case where the fæcal matter is allowed to ferment.

7th. That the receptacle for receiving the ashes can be fixed at any height above the floor of the yard; that children may empty the ashes therein, and so prevent the material from being deposited in the yard, as is the case where the hoppers are too high to admit of the ashes being conveniently thrown therein.

8th. The principle is self-acting, and cannot possibly get out of order except by wilful design.

I have heard it said that water-closets are the means of making the sewers foul, and have a tendency to cause obstruction therein; but such remarks I should imagine are not from those who have had practical experience of the flow of sewage in properly constructed sewers. It is true that water-closets at times do get obstructed under the best appliances. Where this happens it is owing to the machinery getting out of order, want of water, wilful damage, or from the breaking of some pipe. To say street sewers get stopped with the refuse from closets is a delusion. The fecal matter dissolves and turns to liquid. This can be seen in the flow of sewage

from any water-closeted town, as in London, Leamington, Scarborough, and many other large and small places. The liquid state of the fæcal matter may also be daily noticed when emptying the tubs at the dépôt of the Salford Corporation, Wilburn Street. Where cesspools are placed on a sandy soil *without* an overflow, or on a clay soil *with* an overflow, years may elapse before any amount of sediment can be noticed. Fresh sewage, *so to speak*, does not throw off foul gases in properly constructed sewers, where lodgments of liquid cannot take place, and it is well said by some sanitary engineers that in well-constructed sewers there is little need for ventilation.

It is a great waste of time and money to *endeavour* to *realize a profit* or to obtain a sum to justify the nuisance of collecting and storing refuse in the midst of the resident population of a town.

Works for deodorizing the sewage must necessarily be provided, sooner or later, for all towns, *whatever the system of collection may be*, before sewage in large volume can be allowed to pass off into the rivers or adjoining streams.

The difficulty is not, in my opinion, increased, but, on the contrary. Disposing of the whole of the refuse of a town at one point beyond the notice of the inhabitants, in such a way as not to cause a nuisance, must be more convenient than having several works and methods of dealing with the refuse.

The Rivers Pollution Commissioners' Report, 1870, vol. i. p. 25, state, that "the water-closet is practically the only alternative plan of house scavenging which is possible under the circumstances of large towns."

At p. 48: "The common privy and ashpit . . . . . indeed, as already stated in the descriptive part of this report, the privy only professes to receive a portion, and that the least injurious portion of the excreta. The greater part of the urine, and the whole of the fluid refuse from the kitchen and the house generally, is passed directly into the sewer; and as rain finds admission into most of the ashpits, except a few of those more recently constructed, this must act upon the soluble portion of the solid refuse, and carry it into the sewer by the drain, which nearly always connects the ashpit with the sewerage system."

At p. 25 . . . . . "Utilization of fecal matter, which is more easily accomplished under the water-closet than the privy system, the cleanly wholesomeness of the former, and its greater comfort and convenience, are gradually leading to its adoption everywhere in all

houses above the rank of a mere cottage, and it is impossible to doubt that as in Liverpool, so in other Lancashire towns, whatever may be the difficulties in its way, it will ultimately become the rule."

And again, at p. 50, in referring to the dry earth-closet: . . . . . "special service and attention, which the average man or woman will not give, they soon become filthy and offensive. Add to these circumstances the enormous aggravation of all the difficulties of the plan, where not fifty but fifty thousand households have to be provided with the necessary appliances and induced to work them properly, and we can have no hesitation in pronouncing the dry-earth system, however suitable for institutions, villages, and camps, where personal or official regulations can be enforced, entirely unfitted to the circumstances of large towns."

These opinions are borne out to a great extent by the experience of Dr. Davis, Medical Officer of Health for Bristol.

In that city closets constructed on a similar principle have always been in operation more or less, but generally since the application of the Public Health Act to the city. The town of Cardiff is also fitted up throughout the cottage property with pan-closets, which closets have been in use since 1857 to my personal knowledge. In both these towns the waste water is thrown through the seat of the closet. Therefore there is not so large a quantity of waste water passed through the pan of the closet as by the arrangement I propose.

Water-closeted towns, so far as I am able to learn, are the most healthy, and will be found freer from the plagues of zymotic diseases, than where the midden system is applied. The table contributed to our proceedings by Dr. B. Foster last year, shows that the percentage of zymotic diseases in proportion to deaths from each cause to deaths from all causes is less in London and Bristol during the past ten years than in any other of the seven towns there mentioned, being respectively 25·7 and 21·4 per cent.

A large number of ashpits, the property of the Corporation of Salford, have been altered from the old-fashioned privy and ashpit to the principle I propose. They have stood the test of the last severe winter and the drought summer of 1874 and this spring.*

This system will not impede, but will materially assist the work of manufacturing manure or distributing the sewage on irrigation fields, as the whole of the sewage is discharged at one point, to be treated as considered most desirable.

* The rainfall in Salford from November to June amounted to 19·550.

The time is now fast approaching when all sewage and refuse water must necessarily be deodorized before being passed into the rivers and water-courses in this country.

There is not the slightest difficulty in deodorizing sewage and making the effluent water therefrom comparatively pure.

The reports of the Rivers Pollution Commissioners, where the purification of the River Roch, for Messrs. Rigley and Sons, paper manufacturers, is daily going on, the effluent water is considerably superior to the water of the Thames as supplied to consumers in London, "a result which hardly could have been anticipated, considering the very foul condition of the Roch at this part of its course." My own experience on the deodorizing of town sewage fully convinces me that there is no difficulty in the matter; it is simply a question of expense.

I have had fish living in such water for upwards of six months, the water being supplied from the stream passing from the tanks which received the sewage of the town of Leeds, at the rate of $1\frac{1}{2}$ million gallons per day.

It cannot be denied that water is most effective for the removal of filth and the cleansing of a town; and as the cost of obtaining a sufficient water supply to our thickly populated districts is daily becoming more difficult, I am of opinion that there is a great value in store by utilizing the effluent water from sewage for the purpose of a second source of supply for sanitary purposes and motive power. This I advocated at a meeting of this Association, at Liverpool, on January 3, 1874.

It must be borne in mind that whatever collecting system is adopted, the volume of sewage flowing from the town will not be decreased in volume. Works must be constructed for dealing with the sewage, and where tanks are resorted to for that purpose, the capacity of such tanks will not be diminished one inch, and the extent of machinery will not thereby be reduced.

One thousand gallons of water could be raised 220 feet and distributed in Salford for the sum of 2*d.* per thousand gallons. Salford could command an elevation above the centre of the town of from 115 to 150 feet.

These closets do not require any water beyond the ordinary refuse water passing from the house.

It has been said that such closets would be affected by frost in winter and by drought in summer. Since the closets in Salford have been constructed, all these conditions of weather have been met

with, the last summer having been a very droughty season, and the past winter was very severe, and in the early part of this year little or no rain fell.

Since the closets were constructed they have been and are now in good working order. The whole of the inhabitants speaking highly of the improved condition of their dwellings in consequence of the system having been adopted.

The following is the monthly rainfall taken in Salford:

1874.		1875.	
June	·725	January	3·500
July	2·100	February	·625
August	4·000	March	·775
September	3·100	April	·925
October	4·100	May	1·950
November	5·350		
December	2·750		
Snow storm,	·383		

Total rainfall, 29·900.

THE PROFITABLE UTILIZATION OF TOWN REFUSE.

By CHARLES ELCOCK, Manchester.

The system for utilizing town refuse, which I have been requested to describe to you, is that which is adopted by the Universal Charcoal and Sewage Company, Limited, and is one of such extreme simplicity that but a few minutes' inspection of it in operation would give a clearer idea than can be done in a short paper.

The various nuisances, or refuse matters, which come under the notice of boards of health, medical officers, borough surveyors, and sanitarians generally, may be briefly classed as:

The street refuse; the house refuse; the market's and slaughter-house refuse; the excremental refuse; and the sewage proper;—by which last term is meant, what comes down the sewers.

Very many, and just as different, have been the processes patented and practised for dealing with the sewage, as if it were the greatest, or the only nuisance to be disposed of; the processes for utilizing the other nuisances not numbering one-third of those for dealing with it. And yet, it is very apparent that these other nuisances are sources of great difficulty to all our parishes, and involve an outlay of many thousands a year, of which almost every penny must be counted as so much dead loss.

Our own city of Manchester loses annually about 30,000*l.*; Leeds, 23,000*l.*; Glasgow, 25,000*l.*, while Liverpool spends nearly 60,000*l.*

This loss arises because these towns have adopted no system for the proper utilization of the refuse which is daily found within them, so that the expense of collecting and getting rid of it, is so much money laid out yielding no return, except in the form of fever-breeding heaps of decomposing rubbish, technically called "tips."

The process patented by this company utilizes the street refuse, the house refuse, the market and abattoir refuse, and the excrement of towns, and provides *out of the refuse itself*, a medium for

the filtration of sewage proper, waste dye water, &c.; thus presenting a complete system for the removal of all the nuisances which exist in a city, and by their thorough utilization, at least recouping the expense of collecting and conversion into a useful and marketable article, of what will not now, in many cases, fetch the price of its own carriage ten miles.

The whole process consists in carbonizing the refuse, and so converting it into charcoal. By this operation, from 50 to 60 per cent. of the bulk is at once disposed of—an item of no small importance, when we consider the thousands of tons to be got rid of *somehow*. In addition to which, that which before was liable to putrefaction, and invariably constitutes a stinking nuisance, is, by its conversion into a fixed and stable compound, charcoal, rendered innocuous and incapable of putrefaction.

In the town yard at Salford (where, by permission of the authorities), we have been carrying on this process for some time; we use this rough charcoal, thus obtained, for deodorizing the night-soil collected in Salford on the "pail system," and find its action for this purpose perfect. No chemicals are in any way employed to the deodorization—the charcoal only being used for this purpose. The mixture is not subjected to any heat, but dries quickly and spontaneously, and is inodorous. For deodorizing the refuse from abattoirs and fish markets, its action is as complete. For dry closets it is far superior to earth; and in mills, schools, &c., where a number of closets are together, its use has removed what formerly constituted a great nuisance.

A further utilization of the refuse is found, by its conversion into a material suitable for the filtration of foul and discoloured liquids, such as the effluent water from sewage, the foul waters from dyers' vats, brewers' "wash," &c. It serves both to deodorize and decolourize these liquids, and will allow them to filter through it at from three to fifteen times the standard speed of filtration used by the various water companies.

The important bearing which the introduction of the "pail system" has had in reducing the death-rate of those towns which have adopted it is so marked, that it cannot much longer be ignored or overlooked. The great difficulty in the way of its adoption, has been the obtaining of an efficient and economical deodorant, which difficulty is now removed, as the charcoal made from the refuse supplies such an article at a trifling cost.

The "pail system" was introduced into Rochdale in 1870. In

1866 the death-rate was as high as 39·04, and in 1869 it was 29·48. After the "pail" was introduced in 1870, the death-rate sunk to 26·49; in 1871, it was 23·76; in 1872, 24·87; and in 1873, 21·11. So that in four years there had been a reduction from 29·48 to 21·11. The average of the four years 1866–69 is 27·02; that for the four years 1870–73 is 24·05. Had a charcoal system been in vogue, I think it highly probable a still greater reduction would have been known.

Yet more marked has been the result which has followed its introduction into Warrington. The death-rate there was:

In 1866	=	29·38
„ 1867	=	26·00
„ 1868	=	26·00
„ 1869	=	28·27
„ 1870	=	32·38
„ 1871	=	27·84
„ 1872	=	23·30
„ 1873	=	23·08
„ 1874	=	23·38

The "pail" was introduced in 1872, the rate having previously reached in 1870, 32·38, which fell to 23·30, and has remained thereabouts ever since.

At Pendleton, near Manchester, a row of thirty cottages was always suffering from diarrhœa, &c., until Dr. Tatham, the Medical Officer of Health, introduced the "pail" to the entire row, and since then, not a single case has occurred.

In Manchester, in 1868–69, the deaths from typhus and typhoid fevers averaged 519 per annum; while for 1870–1–2–3 the average is only 287 per annum. The "pail" had been introduced and was being extended. It will be remembered that in 1871 the smallpox ravaged the whole kingdom; the deaths in London were per 10,000, 24; in Liverpool, 39; in Wolverhampton, 41; in Newcastle-upon-Tyne, 54; in Sunderland, 86; in Manchester they amounted only to 7.

High Death-rates are Preventable.

It is clearly shown by the returns of the Registrar-General, that all deaths which occur, making the death-rate to exceed 17 per 1000, are caused by some unsanitary condition, and would not occur did that condition not exist. Hence, such deaths are evidently preventable, by the simple removal of the conditions from whence they arise; and the gain in health which would thereby ensue, would be so much gain in wealth.

By the adoption of a well-regulated system of "surface removal," our sewers would be turned to their proper use, viz. the removal of rain or surface waters, to which may, perhaps, be added the domestic or house "slops." But before the water from the sewers was allowed to pass into the rivers, a system of purification should be adopted so as to prevent their pollution. A simple precipitation and filtration scheme would do this; and in fact, we find that the city refuse itself, when treated by one of our patent processes, furnishes the best filtering medium for giving the final touch to the effluent water from the sewage, while again, by this same process, the "sludge" from the sewage furnishes a fresh stock of raw material from which a supply of filterine charcoal may be kept up for the filtration of the sewage.

It will thus be seen that every town possesses in its own hands the raw material, out of which it can produce a deodorant for the vilest of its nuisances, and a means of purifying its sewage.

The financial bearing of the question to the ratepayers is most important, and is briefly this:

Two tons of sweepings make 1 ton of charcoal. The value of the sweepings is about 1*s.* per ton; the 2 tons therefore cost, say, 2*s.* The cost of carbonizing is less than 6*s.* per ton of charcoal produced; this makes the cost of producing the charcoal 8*s.* per ton. We are selling this charcoal to the Salford Corporation at 21*s.* per ton.

Thus, if corporations would introduce a thorough system of "surface removal" for all their city refuse, and utilize it as has now been laid before you, instead of towns paying their 20,000*l.* or 50,000*l.* per annum out of the ratepayers' pockets, there would be that amount saved, and a handsome surplus be found, which might go towards that much-needed object—the improvement of the dwellings of the very poor.

THE MODERN INTERCEPTION SYSTEM AND MANCHESTER SEWAGE.

By MAJOR-GENERAL H. Y. D. SCOTT, C.B., F.R.S.

I do not propose to offer any apology for the form in which I make this response to the request of your late President (Mr. Angell) that I should contribute a paper for your meeting in Manchester. Yours is a body especially capable of discussing and sifting projects for the disposal of the sewage of towns. It is to you that urban authorities must chiefly look for advice on the best modes of escaping from their difficulties; and it is right and proper that those who, like myself, are working at the solution of this difficult problem should submit to you the results they have arrived at, whether these results are obtained in practice or from experiment, or whether they are conclusions based upon reasoning only.

On the last occasion upon which I had the pleasure of meeting you I described to you a process by means of which large and rapidly increasing towns could, with economy and without creating a nuisance, dispose of the sludge of their sewage. I allude to what I have termed the agricultural lime and cement process. On the present occasion I propose to describe, first, the mode in which, as I think, the excretal matters of cesspool and sanitary-pan towns should be collected and utilized; and second, a modification of the agricultural lime process which may be adopted with advantage where interception, as in this town of Manchester, is resorted to.

To gentlemen like yourselves it is quite unnecessary that I should dwell upon the existing state of things in towns of the latter class. You are only too familiar with the foul, demoralizing, disease-spreading, and wasteful nature of the old cesspool, and you can estimate exactly in what respects and to what extent the improved water-tight cesspools and the sanitary-pan or pail system are improvements upon it. Neither is it necessary in addressing a body of municipal Engineers to demonstrate that, if every particle of fæces and urine were excluded from the sewers, the water fouled by a large population would still be of too impure a character and

would be too vast in volume to be dealt with without much expense and trouble.

Nevertheless it may be advisable, with the view of making the *rationale* of the processes I advocate clear to you, to set down briefly certain conclusions which necessarily follow from the acknowledged evils and difficulties of existing systems. These conclusions are:—

1st. Systems which necessitate the frequent removal of excreta are preferable on sanitary grounds to the use of cesspools of large capacity. They are also preferable, in an economical point of view, if advantage is to be taken of the manurial value of excretal matters. Such matters in a state of putrefaction are not only offensive and injurious to health, but the carbonate of ammonia, their most valuable constituent, being volatile, is in cesspools dissipated and lost.

2nd. By a separation of the solid fæces from the urine putrefaction is greatly retarded and the fæces can be rendered inoffensive by a relatively smaller proportion of deodorants which in almost all cases must be of less manurial value than themselves; and, lastly, the look of the receptacle is less disgusting, and the danger of splashing with the uncleanly liquid is obviated.

3rd. Urine should be scrupulously kept out of sewers, for although the nitrogen present ultimately takes the form of ammonia and becomes harmless, yet in the process of change myriads of living organisms are developed, and these rapidly set up putrefaction in other kinds of organic matter with which the decomposing urine comes into contact.

Now the fulfilment of these conditions will facilitate the conversion of the excreta in an inoffensive manner into a saleable manure; and, generally, in the degree to which these operations can be carried out is successful utilization possible; so far as they are neglected, the country will suffer in health as well as wealth.

And the pecuniary result of careful utilization of the excreta of a population is no trifling matter. The saleable value of the solid and liquid excrements of this town of Manchester, supposing them to be reduced to a portable form, worth, say 7*l.* per ton (which can be readily accomplished) would be 177,000*l.* per annum. The amount which the town now obtains for them does not exceed 7000*l.*, or less than 4 per cent. of the full value. In fact, the agricultural benefit derived in this country from the utilization of its excreta is

far more than counterbalanced by the injury done to our rivers and our atmosphere by the reckless manner in which we collect and treat them. Much of their manurial value is allowed to escape into the air we breathe, carrying with it the seeds of disease, and the remainder of their fertilizing ingredients are so degraded by admixture with ashes as scarcely to repay the cost of carriage.

The object of this paper is to show how such waste may be remedied. It would be vain, however, to declaim against the existing system unless I was prepared to offer as a substitute one which would prove a present relief to ratepayers, as well as be more beneficial to the country at large; and I am quite ready to admit that unless the proposed system offers considerable and certain pecuniary as well as sanitary advantages to towns, it would be unreasonable, as it involves an important capital outlay, to expect their governing bodies to adopt it. The payment of high rates becomes, indeed, itself, indirectly, a sanitary question, for it means, in the case of the poor, a scanty supply of food and clothing and the want of good lodging. Moreover, schemes involving the production of sewage manure have not been so successful in the past as to encourage towns to invest money in the preparation of manures. The causes of these failures are, however, sufficiently obvious when the question is looked into. The manures which have been made have been invariably of very feeble character, worth on the chemist's valuation in some cases as little as 15*s.* per ton, and rarely reaching 3*l.* per ton.

The result of this is that the cost entailed by the cartage and spreading of such bulky manures as compared with their fertilizing elements is very large, and the farmer finds it more economical to purchase manures of higher value. Mixed manures, in fact, of a less value than 5*l.* or 6*l.* per ton do not command a market, but at 6*l.* or 7*l.* per ton they command a more ready sale than if more concentrated, because when of this degree of strength they can be more equally distributed, and can, without further preparation or admixture, be at once drilled in with the seed.

Now, by proceeding on correct principles, it is by no means a difficult matter to prepare from excretal matters in the form of night-soil and urine, and from sewage precipitates, a manure having a value of 6*l.* or 7*l.* per ton; and since such manures find ready acceptance with farmers, the chemist gives to their fertilizing ingredients, as determined by chemical analysis, their full theoretical value.

Excepting, indeed, for special purposes, a manufacturer need not trouble himself to prepare more concentrated manures than such as the above prices would indicate.

Having thus pointed out the object to be aimed at, I shall now proceed to show how a saleable manure could be made by the town authorities of Manchester from the materials at their disposal. I hope to prove to you that they can do much better with these materials than pollute the River Irwell with them as they do now, or sell them in a form in which they do not return to the town one-third of the sum which it costs the ratepayers to remove them.

Though the arrangements which are being carried out in Manchester are not the best adapted for my purpose, I should propose to make only some slight modifications in them. It is well known to those interested in sewage matters that the system now being introduced in this town is that of a tub placed in a closet fitted with a cinder sifter, the fine ash being thrown on the excreta, and the large cinders falling into a recess for reuse as fuel by the household. In theory this system has many advantages, but in practice it is not so successful as it ought to be, owing to the careless manner in which the sifting apparatus is treated in the houses of the improvident. A year or so ago I visited five of these closets in different parts of the town, under the guidance of one of the inspectors, and three of the sifters were choked. This was owing either to the ashes having been thrown on to the grid while they were wet, or from their admixture with vegetable matters. Doubtless when the people become better accustomed to the closets they will treat them with more care; but in the houses of the poor so much of the household work is done by little children that the deodorization will be always imperfectly carried out. So far, however, as the mere pecuniary results of my process are concerned this failure will be rather an advantage than otherwise, as the ashes, whilst they deodorize the excreta, also seriously degrade the manure prepared from them. On the other hand, when the grids are kept open and in action, my plans will secure better deodorization than at present, because I introduce into the tub a perforated diaphragm, at about three-fifths of the way down, so as to allow of a rough separation between the solids and liquids. In Manchester, the chamber slops are, to a great extent, thrown into the tubs, and it is manifest that the fæces will be much better deodorized if the water be drained from the solid matters than if they are left floating in it. In the former

case the ashes will cover them even if their amount be small; in the latter case the ashes will do but little unless they are used in large quantities.

It would be preferable, instead of using ashes, to employ the refuse animal charcoal resulting from the manufacture of yellow prussiate of potash, both because it possesses fertilizing properties of its own, and because, as it is very effective as a deodorizer, a small quantity of it suffices. Half an ounce for each use of a closet is ample, and thus the addition of what have been aptly termed "profligate associates" is comparatively small. There are other means of deodorization available, but as I think it desirable to avoid, as far as possible, departure from existing plans, I omit further mention of them here.

Supposing, then, that the tubs are collected, as at present, and taken to a factory situated on one of the existing night-soil wharves, and that the urine from factories, public urinals, &c., is also conveyed there, the process of manure making is conducted as follows:

The solid fæces are lifted from the tubs by handles attached to the diaphragm on which they rest, and are thrown into a mixing mill with a sufficient quantity of slaked lime to make their deodorization complete. After these ingredients have been thoroughly incorporated, a solution of phosphate of iron, of alumina, or of lime, in sulphuric acid, is added until the free lime is neutralized. When this has been done, the compound is removed to a heated floor to dry it, or the moisture is expressed from it so far as to enable it to be stacked in thin slabs, such as are produced by the machine of Messrs. Needham and Kite, and it is then air-dried. The process need not be in either case offensive. After the drying is completed the substance is reduced to a powder.

The liquids are emptied into the first of, say, six vessels, four of which contain phosphate of magnesia in a powdered crystalline state, and the last two lime which has been slaked to a fine powder. The liquid is gradually passed from the first vessel of the series to the last. In each of the first four vessels it gives up a portion of the ammonia it contains to the phosphate of magnesia; in the last two, such phosphoric acid as would otherwise be carried away in solution is detained by the lime, as precipitated tribasic phosphate of lime.

In this manner the phosphate of magnesia in each vessel is in succession converted by degrees into ammoniacal phosphate; and

at any particular stage of the operation the conversion in the first vessel is complete, or nearly so, and is in a less and less advanced stage in vessels numbers 2, 3, and 4. The liquid may be either made to pass by upward filtration through layers of phosphate of magnesia in the different vessels, or the salt may be stirred up at intervals, and after a period of rest, to allow the phosphate to settle at the bottom, the liquid can be siphoned off or pumped into the vessel next in the series.

As soon as the solid contents of the first vessel have been fully converted into ammoniacal phosphate of magnesia they are removed to another series of vessels of smaller dimensions, in which the ammonia is removed from the salt, and brought into the liquid condition by means of hydrochloric or sulphuric acid; as little water as possible being added.

The ammonia being thus dissolved as chloride of ammonium or sulphate of ammonia, the phosphate of magnesia is ready to be conveyed back to the fourth of the series of urine vessels, to be again charged with ammonia. The solution of the salt of ammonia formed is concentrated at a gentle heat until it crystallizes, when it is ground to a powder and is subsequently mixed with the dry and powdered fæces.

The solid contents of vessel number 5, when the conversion of the lime into phosphate is complete, are likewise dried, ground, and added to the manure.

The effluent which results from the process is inoffensive. So far as it has smell, its odour resembles that of orris-root (not to say that of violets), with a suspicion of spirits of hartshorn.

The foul water from the pigsties, slaughter-houses, stables, domestic operations, and such water-closets as there may be, has still to be dealt with and cleansed; and in a town like Manchester, having a pail system in operation, and consequently a manure to dispose of, I deal with it as follows, by a modification of the agricultural lime and calcination process:

I divide the depositing tanks into two compartments. In the first compartment I allow simple subsidence to take place, and the deposited matters I deodorize as they are removed from the tank in the manner which will be described presently. With the effluent from the first compartment I mix milk of lime, and allow the precipitate produced to settle in the second compartment. The precipitate thus obtained is collected, dried, and calcined, and the lime which results (and which will contain the greater portion of the phosphoric

acid which was in solution in the sewage) is employed in the precipitation of a fresh quantity of effluent from the first compartment of the tank. The operations of precipitation, calcination, and re-precipitation are carried on some five or seven times, when the lime will have become too much charged with phosphoric and silicic acids to render the continuance of the process economical. The phosphatic lime which results is then used for the deodorization of the deposit in the first compartment. In order to carry out this part of the process the sludge from the first compartment is run into a small tank with a sufficient quantity of this phosphatic lime to deprive it of noxious smell, and then the excess of free lime is neutralized with a solution of a phosphate of iron, alumina, or lime, prepared by digesting one or other of these substances with sulphuric or hydrochloric acid. After agitation with the phosphate solution the deposit is allowed to settle, and the supernatant liquid having been drawn off or expressed, it is dried and reduced to a powder. This also is subsequently mixed with the dried and powdered fæces.

The effluent from the second compartment, being one from well-limed sewage, may be safely admitted into streams of large volume not used for drinking purposes. It may, however, be further improved by the addition to it of a solution of a cheap phosphate dissolved in mineral acid in an extra tank provided for the purpose. This process will remove the excess of lime, and the precipitate will contain at the same time about 2 per cent. of its weight of nitrogen, yielding a manure which, in the dry condition, has a value of 7*l.* or 8*l.* per ton.

The amount of improvement in the sewage water to be expected from such extra treatment may be inferred from the fact that the amount of putrescible nitrogen removed by it would, in the case of Manchester, exceed 300 tons per annum. Whether it should be adopted in any particular case must depend on the relative facilities which the locality affords for cleansing by intermittent downward filtration, or by irrigation, or by a combination of these two processes.

The meeting will naturally desire to be informed what would be the cost of the operations which have been described. I therefore add to this paper a summary showing the expenses of, and probable returns from, the process, and I now submit my plan to your criticism.

I.—Cost of Dealing with Dry Sewage.

The quantity of excrement voided annually by a population of 350,000 is as follows: *

Amount of fæces	11,363·8 tons.	
Containing nitrogen .. .. =	167·3 „	
„ phosphates .. .. =	235·55 „	
Amount of urine .. .. .. =	147,111·3 „	
Containing nitrogen .. .. =	1,317·75 „	
„ phosphates .. .. =	591·5 „	

I may assume that four-fifths of the solids can be collected and one-half of the liquids. Therefore of fæces there will be recovered per annum .. .. 9,089·5 tons.

Containing nitrogen .. .. .. =	133 „	
=	161 „	of ammonia.
„ phosphates .. .. =	189 „	
Value in a finished manure †	£14,770	

And of urine there will be recovered 73,555·6 tons.

Containing nitrogen .. .. =	658·8 „	
=	798 „	of ammonia.
„ phosphates .. .. =	294 „	
Value in a finished manure†	£68,250	
Or a total both in fæces and urine of ..	£83,020	

The amount to be collected and carried to the factory will be:

Fæces	9,100 tons, nearly.
Urine	73,500 „
Total	82,600 „

For the conversion of the above quantities of excreta into a manure the following materials and plant will be required, exclusive of the pails or tubs used for collection and of the wharves or dépôts to which the dry sewage is conveyed for treatment, but inclusive of the cost of carriage and all subsequent expenses:

2,800 tons sulphuric acid † at 5*l.*	£14,000	
140 tons phosphoric acid at 45*l.*	6,300	
Magnesia, lime, charcoal, &c.	2,625	
		£22,925
Collection, 82,600 tons at 4*s.*	..	16,520
Deodorizing and drying 9,100 tons of fæces, and reducing the same to 4,200 tons of manure at 10*s.* ..	2,100	
Collecting from urine 798 tons of ammonia, as ammoniacal phosphate of magnesia, extracting ammonia from same with sulphuric acid, and drying the resulting compound, 4,550 tons at 3*l.*	13,650	
Carried forward	15,750	39,445

* The table from which these figures are taken is given from the first Report of the Rivers Pollution Commissioners. The data are derived by Röder and Eichorn from the researches of Wolf and Lehmann.

† Ammonia taken at 80*l.* per ton, phosphates in fæces at 10*l.*, and in urine at 15*l.* per ton.

Brought forward	£15,750	£39,445
Mixing, bagging, agency and sundry expenses, 8,750 tons at 1*l.*	8,750	
		24,500
Interest on capital of 42,000*l.*, expended upon works and plant at 10 per cent.	..	4,200
		68,145
8,750 tons of manure, value in fæces and urine ..	83,020	
Value added in phosphoric acid	5,600	
		88,620
Balance in favour of process		£20,475

II.—Cost of Dealing with Liquid Sewage* by Subsidence combined with Double Precipitation by Lime and Soluble Phosphates.

Cost of labour and materials†:	
437·5 tons of phosphoric acid made soluble in hydrochloric acid at 15*l.* per ton	£6,563
63,000 tons of sludge treated with 1,400 tons of phosphatic lime and 437·5 tons of phosphoric acid, and collected, dried, and powdered, producing 6,650 tons of manure at 15*s.* 6*d.*	4,882
Collecting, drying, and calcining 140,000 tons of carbonate of lime sludge = 14,000 tons of deposit and 8,400 tons of phosphatic lime at 25*s* per ton calcined	10,500
Interest on capital 35,000*l.* at 10 per cent.	3,500
	£25,445

Second Precipitation with Soluble Phosphates, as a subsequent Process to the above.

1,050 tons of phosphoric acid made soluble	£15,750	
Collecting 70,000 tons of precipitated phosphate and reducing the precipitate to 5,250 tons of dry manure in powder, at 1*l.* per ton	5,250	
Interest on capital 17,500*l.* at 10 per cent.	1,750	
		22,750
Value of 5,250 tons of manure at 5*l.* 10*s.*		28,875
Balance in favour of process		£6,125

III.—Cost of Combined Treatment of Dry and Liquid Sewage.

I will not in this estimate for Manchester include the above cost of this second precipitation, but I may, in conclusion, set down the

* Forty gallons per head is assumed as the ordinary dry-weather flow.

† The capital for building the tanks and providing the plant is omitted. In all probability the majority of the towns of this country, whether midden or water-closet towns, will be compelled after this Session of Parliament to provide depositing tanks, and as the amount which will be expended upon them will vary not only with the nature of the locality, but also with the style of workmanship which the towns may think it necessary to adopt, no estimate is taken for tanks, except in cases in which the modification of the process requires more tank accommodation than would be needed for simple subsidence.

total sum to be obtained by the combination of the manures derived from the dry and wet processes:

6,650 tons of manure produced from liquid sewage valued at 3*l.* per ton*		£19,950
8,750 tons of manure produced from dry sewage		88,620
15,450		£108,570
	Or about 7*l.* per ton.	

The final result to the town of Manchester by the adoption of the processes I have advocated would be that the expense of the treatment of the whole of the dry and liquid sewage would be covered, and if we assume the manures to be sold at 6*l.* 10*s.* per ton, the account would stand thus:

Expenses entailed by dealing with liquid sewage	£25,445
„ „ dry „	68,145
Total	93,590
15,400 tons of manure at 6*l.* 10*s.* per ton	100,100
Balance profit to the town	£6,510

* The theoretical value is from 4*l.* 10*s.* to 5*l.*, but a manure of even this indicated value would scarcely command a market at full prices.

THE LEEDS BOROUGH SEWAGE WORKS.*

By Mr. R. GOODALL.

The present population of the borough of Leeds is about 280,000; the acreage 22,974. The drainage acreage is 4893 and 6 perches; representing a population of 230,000. A rate of one penny in the pound raises about 2500*l.*

The water supply is something like 7,000,000 gallons for the twenty-four hours; and the flow of sewage about 12,000,000 gallons in the same time.

The Leeds sewage is a comparatively light one; its solid matter being only about 96 grains per gallon. The Salford sewage, Wooden Street Sewer, March 15, 1869, total solid matter was 294 grains; that of West Ham, December, 1873, 603½ grains; Lancaster, 30th September, 1868, 28 grains; and London average, February to June, 1869, 45 grains per gallon.

It is a very bad sewage to treat, owing to the large amount of colouring matter it contains. This colouring matter (hitherto regarded as a compound of chromium) is at the outfall for half an hour, an hour, and sometimes for an hour and a half; on two, and as much as three different occasions in the day. It generally makes its appearance when the sewer is the fullest, and is a great tax to the skill and patience of the operator.

In summer the sewage is about 12° above the temperature of the atmosphere, and about 30° in winter.

I entered to the new works on the 3rd of September, 1874. Owing to the incomplete state of the machinery, I could not commence the treatment of the sewage until the 27th of October. I then treated for 3 hours 25 minutes. The running, after this date, was of a very irregular character, from the same cause, so that on the 31st of December I had only succeeded in making 105 hours 45 minutes; treating about 58,000,000 of gallons.

* Report of the Operations at the Leeds Borough Sewage Works, from the 1st of October, 1874, to the 2nd of April, 1875, on behalf of the Clarifying and Utilization of Sewage Company, Limited. By Mr. R. Goodall, General Manager.

The committee at the Town Hall told my directors that owing to so many stoppages they had not had a fair chance of judging of the process, or of ascertaining the cost, and asked that my operations might be continued for three months longer. To this request my directors assented, and I commenced afresh on the 8th of January last. The longest consecutive running I could manage was from the 2nd to the 10th of February; having had to stop a few hours only for repairs of straps, &c., I call it consecutive running. The time run was 172 hours 15 minutes, which gives 86,000,000 of gallons, at the rate of 12,000,000 for twenty-four hours.

The cost of chemicals was 142*l.* 18*s.* 6*d.*; equal to 16*s.* 6*d.* per hour, or 33*s.* 8*d.* per million gallons. The items—coals, wages, gas, oil, &c.—during the time were within 88*l.*, which bring up the whole cost to 26*s.* 8*d.* per hour, or 53*s.* 4*d.* per million gallons.

The materials I use are: slaked lime, waste carbon, town ashes, and sesquipersulphate of iron. The first three of these I mix with water and grind into a paste or mortar; the proportions varying with the changes in the sewage. This mortar is put into the sewer just where the centrifugal pumps take up the sewage, thus the whole is well mixed together by the action of the pumps. As the partially treated sewage passes along the horizontal pipe, it receives the iron liquor and fresh agitation, and the mass flows into the settling tanks, which completes the process.

The chemicals act on the sewage thus: The slaked lime decomposes the salts in solution, such as phosphates, sulphates, &c.; and their respective bases, such as ammonia, being absorbed by the carbon and ashes, are precipitated along with the other impurities in the form of sludge or mud. The iron liquor has the effect of throwing down the excess of lime, quickening precipitation, and deodorizing and brightening the effluent.

The result has been, so far as I know, from first to last, a uniformly satisfactory effluent. In the majority of instances, when the works came to a stand, after a rest of twenty to thirty minutes, the bottom of the tanks could be distinctly seen—a depth of from 6 to 7 feet.

That there was the absence of anything like an unpleasant odour from the process may be inferred from what some of the gentlemen visiting the place said, viz. that had they been led blindfold on to the works, they would never have supposed they were sewage works, all was so free from smell.

The Precipitate.

When I first went to the experimental works at Knostrap, in October, 1873, I told the committee that I believed there was a small manurial value in the sludge, but that it was otherwise worthless. I still adhere to that opinion, in the main, after having made from it, carbon, deodorizing powder, sal-ammoniac, and lastly, reused it for treating purposes.

Judging from my own analysis, and one or two experiments made on small patches of grass land, I think that in the course of two or three years' time the dried sludge will sell for 1*l.* per ton. The cost of thoroughly drying it I estimate at 10*s.* per ton, which leaves a surplus of 10*s.*

Now, in treating the Leeds sewage, I use about 35 to 40 tons of materials in the twenty-four hours, which give about 60 tons of snuff-dry manure.

Looking at the subject in this light, the account would be as follows:

Dr.	£	*s.*	*d.*	Cr.	£	*s.*	*d.*
To 12 million gallons of sewage per day, at full cost, 2*l.* 13*s.* 4*d.*	32	0	0	By 60 tons of manure, at 10*s.* = ...	30	0	0
				By balance	2	0	0
	£32	0	0		£32	0	0

This shows a loss of 2*l.* per day, or 730*l.* per annum, to be made up out of the rates. I have allowed nothing in this calculation for interest on the outlay.

I may add, in conclusion, that the process is in full work at several mills in the neighbourhood of Guiseley; also, that I hope to commence, in a few days, some new works at Manor Mills, Yeadon, of quite a model character, as regards both machinery and treatment.

DISCUSSION.

Mr. R. Vawser (Warrington) said, he should scarcely have ventured to say anything at that meeting, if Mr. Elcock had not referred to the town which he (Mr. Vawser) represented. He believed Warrington was more fortunate than most towns, because, instead of adding a very large sum to the rates each year, or being compelled to issue sensational reports as to the amount of profit, they were able to dispose of the whole amount of manure manufactured without any loss whatever. The receipts for the sale of the manure covered the whole expense of collection, and the only additional expense was, that a man was employed specially to superintend the work, and his wages were paid out of the rates. Except for that, the process in Warrington would be self-supporting. One other matter in reference to the process which Mr. Elcock advocated. He believed it was a very valuable system for disposing of the dry refuse from the surface of the streets. So far it was right in reducing that material to charcoal, but they had had no experience yet of its value for purifying sewage. In Bradford, some time ago, an experiment was made with the charcoal system, somewhat different, he believed, to that which Mr. Elcock recommended, but it failed; and how Mr. Elcock would guard against the same failure in his works, he (Mr. Vawser) did not pretend to say, but perhaps Mr. Elcock could tell them. It was a very different thing to make the experiment on a working scale sufficiently large to purify the sewage of a town, than to perform with bottles in that room. The sample that had passed round the room was all that could be desired. He had not tasted it, but he had no doubt that it would be perfectly tasteless, and would, if supplied to the Rivers Pollution Commissioners, satisfy them completely. That, however, was quite a different thing to doing the same work on a manufacturing scale. Some six months ago he offered Mr. Elcock the opportunity of trying his system at some works of his (Mr. Vawser's) own, on a manufacturing scale, and he offered to place the works entirely at his disposal for the experiment. Mr. Elcock would not avail himself of the offer, and he (Mr. Vawser) did not think anybody should come there to tell them what they could do, unless he was prepared to accept a challenge of that kind. With regard to other points, everybody would agree as to the necessity of very frequent removal of

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the night-soil, and the pail system was, he believed, of all others the system which ensured that in the highest degree. He had intended to say something about the purification of sewage by chemical processes and by irrigation. Purification of sewage by irrigation was all very well in a place where they had what he might call pure sewage —if there was such a thing. At any rate, he meant simply house sewage, and not sewage of particularly noxious character; but that was out of the question in towns such as in Lancashire. It would be impossible to place the sewage of Manchester on land for irrigation purposes, unless it previously underwent some cleansing; and if they had to apply any cleansing purposes whatever, it must be such as would completely purify it, without rendering it necessary that it should pass over the land again. In Warrington there was a great deal of chemical waste and refuse, which would be very injurious to any kind of vegetation. He did not think any means could be found of purifying sewage, except by some chemical process; and he thought that chemists ought now to be able to find some system for doing it effectually, without putting it on the ground.

Mr. Ellice-Clark (Ramsgate) said, he would wish to make a few remarks as to the comparative merits of the pail and water-carriage system. He thought that that question had been settled long ago by the Commissioners appointed by Parliament. Most valuable returns had been made on both those subjects, and he thought there could be no doubt whatever that water-carriage was far superior to any system of removal by tubs or pails. Mr. Vawser had said that it would be impossible to apply the sewage of Manchester and other manufacturing towns over the land, in consequence of its being largely mixed with chemicals, but the Commissioners laid it down as a rule that manufacturers ought to consume all the refuse from the manufactories themselves, and that no such refuse should be allowed to enter into the sewers. There was no doubt that allowing all that refuse to enter the sewers did make up a very difficult compound to deal with, not only to deal with in regard to purifying, but in actually passing through the sewers. The discharge simply of heat, for instance, into sewers had a very serious effect, because it raised their temperature to such a degree that it was very difficult to ventilate them. Therefore, he thought that when it was stated that sewage could not be applied to land, simply because it contained certain chemicals, he thought the impression was an erroneous one. It had been laid down by the Commissioners that chemicals and refuse from

factories should not be allowed to enter the sewers. One gentleman had stated that the fever death-rate in Manchester was lower than in other towns in England, but on a reference to the Proceedings of last year, he found that such was not the case. He believed that the fever death-rate in Manchester was as high, if not higher than in other towns, with the exception of Liverpool, which was notoriously unhealthy. It was lower in the towns with the water-carriage system, than in those with the removal by pail or tub system. He believed that the laws the Sanitary Engineers had laid down, were summed up in the practical remark of the British Association Committee, that no system could be considered a perfect one, unless the decomposing matter that accumulated around our dwellings was removed as quickly and as effectually as possible. To those who had experience of living in towns where the midden and pail system was in vogue, and in towns where, really well carried out, the water-carriage system was in vogue, the difference was, at all events to the eye, very remarkable. There was no doubt—as he in the paper which he was about to read should endeavour to show—that the water-carriage had not had in any town in England a fair chance. He believed the town in which it had been tried to most advantage was Portsmouth. There the sewage works had been well designed * and carried out, and the house connections and all details thoroughly attended to, and the consequence was that the death-rate had been lowered considerably, and now it was the second of all the large towns in England in that respect. He was quite astonished to hear any modern sanitarians argue in favour of removing the excreta through the streets in preference to the water-carriage system. The difficulty to him, and it appeared to all the Engineers of the present day, was not as to what system of drainage should be adopted—that appeared to have been settled some time ago—but as to what they were to do with the sewage. One gentleman had come forward at that meeting, and others had also sought to prove, that by the use of certain chemicals a valuable manure could be got out of sewage. At Birmingham, all those patent processes had been described, but the practical men came to what he considered a most sound conclusion, that town sewage was a nasty thing, and that people must pay for getting rid of it. There were no means of getting rid of the human excreta from around dwelling-houses without paying, and in some cases, according to the configuration of the ground, without paying handsomely

* Designed by Mr. Angell, Past President.

for it. It should not be a question of cost at all. The first question to be considered was the health of the people. Of course, one of the difficulties—in fact the greatest difficulty—Borough Engineers had to contend with was the increase of rates; but he was perfectly sure that an increase in the death-rate meant an increase in the rating. Mr. Fowler, the Surveyor of Salford, appeared to him to have devised a very clever system of utilizing the slops and rain-water. There was no doubt that in many towns there was a very great difficulty in obtaining a proper supply of water for the purpose of flushing the sewers and having a sufficient flow, but when he told them that they could raise a thousand gallons of water for twopence, and distribute it, in Salford, that appeared to be remarkably cheap. He was astonished that the sanitary authorities there were not more forward in carrying out in its entirety the water-carriage system, on that score alone. In Ramsgate they had to pay 1*s.* for the thousand gallons, and then to distribute it; but the ratepayers found it much cheaper to pay 1*s.* per thousand gallons for water to carry off the refuse, than to cart it away. The Corporation of Salford ought to go to some of the towns of England where the water-carriage had been carried out in its entirety, before acting on the extraordinary doctrines put forward by some gentlemen, which, as far as he could gather, instead of making low rates and giving large profits out of the sewage, gave quite the opposite results.

The Hon. Secretary (Mr. C. Jones) expressed his belief that sanitary authorities would never come to an absolute agreement on this subject. They were almost as far from it now as they had been at Birmingham last year. Some eminent writer had said that when people arrived at the highest degree of civilization they went back to first principles. They had gone some way back in that part of the world now. He could not approve of the earth-closet or pail system. There was something that did not seem comfortable to him about it. Probably it might be very nice. He had not tried it, and therefore he would not pass a very strong opinion upon it. But he had a preference for the water-carriage system. With Mr. Clark, he said sewage was undoubtedly a nuisance, and they wanted to get rid of it. They wanted to get it as far from them as possible, and it was a secondary question whether they could make anything of it or not. If they could get it away, either in charcoal, in Italian rye-grass, or in anything else to make it serviceable, so much the better. A very important point with

the Sanitary Engineer or Surveyor, as well as with the ratepayers, was the amount of the bill; and under all the circumstances, therefore, both the Engineers and ratepayers had much about the same feelings in connection with the matter. He was surprised, however, to hear Mr. Vawser speak of sewage in connection with the chemists. Mr. Vawser, he believed, said it was strange that the chemists did not find a material to, in some way, deal with the sewage water so that it might pass away without any necessity for its coming on the land. His (Mr. Jones') impression was that the land was the proper place for it. He thought the point with the chemist was to show how the water could be got on the land possessing in the highest degree manurial properties. The manufacturers should be prevented from polluting the sewage, and therefore by all means oblige them to deal with their chemicals in their own places; and he was convinced that if the laws of the country were strong enough to oblige them to do that, a great step in advance would be made. One of the greatest polluters of rivers in England had said to him, "Bring in a law obliging us all to do it, and we will do it." (Hear, hear.) It was most important that the sewage should be pure. If they had pure sewage, they had money. He thought one of the great points was that they should put the sewage on the land; not dirty sewage, but pure sewage—clarified sewage. He would not allow one drop of dirty sewage to go on the land; it had no business to go on the land when it was dirty. He was now putting clear sewage on land in Kent. It was perfectly clear, and there was no offence from it. It might be put under a drawing-room window, and yet no inconvenience would arise from it. Therefore the important point was by all means to have the sewage clarified, and freed from all noxious materials. If they did that they would do as he was doing now—making 65*l.* per acre per annum by Italian rye-grass. He believed that an enormous quantity of this clarified sewage could be taken on a small quantity of land. One hundred acres of land would be sufficient for the purposes of his borough, provided the sewage was pure. Italian rye-grass might be grown on such land as long as milk was required, and as long as we were what we were, and boys were growing up. Milk would be produced by the use of rye-grass, not, as they had been told some time ago, full of pollution and that sort of thing, but, where the clarified sewage was put on to the land, perfectly pure. Italian rye-grass might be cut a quarter of an inch from the ground, without a particle of offensive matter

being found on it. Putting the maximum of clarified sewage on the minimum of land, and so getting from it the heavy crops he (Mr. Jones) was growing, would, he believed, ultimately be found the most successful plan. He had stuck to it a long time, and he was sticking to it still. There was great value in town sewage when properly applied to the land.

Mr. Lemon (Vice-President) said, he was afraid they were what he might call rushing into a great error, in trying to find out what was the best system, with the view of trying to adapt that system to every town. That was a great mistake on the part of sanitarians. There were systems which were good according to local circumstances, and to lay down fixed principles of irrigation or other processes as applicable to every town in the kingdom was a great mistake. They should be guided entirely by the local circumstances of each town. With regard to the systems of Dr. Leigh, Medical Officer of Health of Manchester, and of Mr. Fowler, of Salford, he thought there was one weak point in both their systems. In all towns it was a principle that the sewage should be got rid of as quickly as possible, before decomposition set in. He had been to look at Dr. Leigh's model, and it was not thoroughly self-acting. He thought a good dry closet should be self-acting to this extent—that the moment a person was done using it dry earth should be scattered over the excreta, to render it innoxious. Another objection to Mr. Fowler's system was that there was no water thrown into the closet, except when some person went there to throw in slops. That was a great objection to his scheme; for the great principle of a good water-closet system was that the excreta was removed immediately from the pan, and carried off in what might be considered a short time some few miles away from the house, which he thought was the most important feature in the water-closet system. Then a great deal too much was made out of the quantity of water used for a water-closet. In good water-closet towns, where there were cisterns, and the closets used a gallon and a half, or at most two gallons, each time they were used, as in his borough, the quantity of water used became very small indeed, as compared with the quantity used where the dry system was in operation. He was surprised to hear the Water Engineer of Manchester say that the water per day consumed by each closet was about twenty gallons. In water-closet towns the quantity of water consumed ranged from twenty-five to thirty gallons per head per day, including trade purposes; so that it

might be taken that the water used for water-closets per day was about five gallons per head, and that was not a question of great cost, when Mr. Fowler said he could raise the water at Salford for twopence per 1000 gallons. He believed that General Scott struck the key-note of the whole thing when he said, "By all means get a good concentrated manure." The great cause of the difficulty of disposing of sewage manure was its want of portability and deficiency in manurial value. When they got a sewage of sludge the farmers would not give a shilling a ton for it. Farmers could not be got to hamper their land with a large amount of sewage sludge which contained a very small amount of manurial value. They would sooner pay 12*l.* or 13*l.* a ton for good guano, than buy this sludge as low as a shilling a ton, showing at once that if towns wanted to get rid of the difficulty in disposing of the sludge, they must, as General Scott had put it, try to concentrate it as much as possible. Mr. Ellice-Clark had made some remarks as to the low death-rate of Portsmouth. He (Mr. Lemon) attributed that in a great measure to the large number of what he called the able-bodied and healthy population there; that was to say, there was a very large number of soldiers and sailors there, who were the pick of the people, amongst whom there was a very low death-rate, and that was one reason why the death-rate was so low in Portsmouth. If they took away the soldiers and sailors, and calculated the death-rate in the population pure and simple, they would find it different. As to the dry system, it was found to be used mostly in poor dwellings. They found that in Manchester and other towns where the dry system prevailed, the rich would not have it at all. If there was anything in the dry system, he should be pleased to see it in the Town Hall of Manchester. If it was a good thing they could afford to put it in the best places. The proof that it was not a good thing was that the rich would not have it, and it was forced on the poor people.

Mr. Pritchard (Vice-President) confessed that he had come to the conclusion, like Mr. Ellice-Clark, that practically the disposal of the sewage was a question that had been solved for some time. It had been stated by General Scott, and it would be endorsed, he believed, by every Sanitary Engineer present, that to obtain a pure effluent the sewage must pass through the land. It had also been stated that the system of the disposal of sewage must be so designed as to suit the different towns and localities. He granted that; but still he said that with scarcely one exception, in any town in this

country the land could be made the ultimate receiver of the sewage effluence. If they took irrigation in a broad view, they could obtain, as Mr. Jones stated, crops of enormous value. He himself might refer them to a farm belonging to the Earl of Warwick, where, during the last season, mangolds were grown to the extent of considerably over eighty tons per acre. No other manure was used on the land but that pumped up from the towns of Leamington and Warwick, near which the farm was situated; and this sludge was sold for something like 20*s.* or 21*s.* per ton. It had been said that if there was to be no difficulty in disposing of the sludge, it must be concentrated; but in the case of Leamington the sludge was pumped on to the fallow land, and not a particle passed into any depository or tank, or if it did, only for such a period as would allow the manager in charge of the farm to prepare his fallow land to receive it. From his experience of some years past, and from careful attention to the subject, he adhered to the opinion he had given now some years ago, that a combined process of precipitation, deposition, and irrigation was the only effectual means of disposing of the sewage.

Mr. Monson (Acton) said, he was sorry to hear Mr. Pritchard say that the sludge and the whole contents of the sewage were pumped on to the farms near Warwick and Leamington. When he went over those farms he considered that there were defects in the system of using the sewage. He thought the question of sewage had been entirely settled last year. He thought they had arrived at the conclusion that the best way of removing the excreta was by suspension in water; and with regard to the treatment of the sewage water they should first deal with the solid matter. There should be legislation in reference to solid matter; and if purity was then required, the cheapest means was to pass the sewage through the land. He had arrived at that conclusion, and it would be very difficult to induce him to alter it.

Mr. Harpur (Merthyr-Tydfil) said, in reference to Dr. Leigh's remarks with regard to disinfectants, that he had had a little experience in that matter himself. He might mention one instance in which fever of a very malignant character had broken out. The house in which it made its appearance was surrounded with dwellings, and in course of three or four days six of the inhabitants of the house were prostrated. They were taken away immediately to the fever hospital. The house was thoroughly disinfected. It was well fumigated, and all the clothing and bedding were placed in a

hot-air chamber of a temperature of 260 or 280 degrees, and the result of that process was that the fever entirely ceased. There was not a case in any of the adjoining houses, but it was very probable that if it were not for the measures taken the fever would have spread and have proved exceedingly disastrous. With regard to closets, he had to do with a town where they had over ten thousand workmen's cottages. The water supply, although considered good, was but of a limited character, and if cisterns were to be constructed for all those closets, he had no hesitation in saying that they could not be supplied on the constant system. The intermittent system would have been found necessary. At present the constant system of supply was in use; but within the last few years closets had been constructed in connection with seven thousand of those workmen's cottages without laying the water on. The whole of the closets were hand-flushed and worked exceedingly well. They had in operation in Merthyr-Tydfil not only irrigation on purity principles, but they had twenty acres of land laid out on the filtration system—the intermittent, downward filtration system. In addition to those twenty acres, over three hundred acres were now laid out for purity irrigation. From the whole of his experience he should say that the water-carriage system was the system that ought to be adopted everywhere. What would Manchester be, for instance, if the dry system was carried out thoroughly? What state would the town be in without a system of sewers? And having a system of sewers, why not use them for sewage purposes? At Merthyr-Tydfil they strained the whole of their sewage, and the greater portion of the sludge contents having been extracted, it passed on to the land and caused no nuisance. He had been over the land with visitors many times, and not a single visitor had ever spoken of having perceived a nuisance.

Mr. Deacon (Liverpool) thought the authors of several of the papers might not be very well satisfied with the treatment they had received, but he thought it was to a great extent due to the fact that very few of those present understood the papers, and it seemed impossible that they should understand them from having heard them merely once read over. One could not carry a great number of figures or chemical considerations in one's mind and argue upon them as he would if he saw the papers in print beforehand; and bearing that matter in view, he would take an early opportunity of bringing before the Council the propriety of distributing proofs of the papers among those Members who took an interest in the special

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subjects. It was of course very easy to discuss the subject of the water-carriage *versus* pail-and-midden system; but it must, as several gentlemen had already said, be considered in reference to the conditions of particular towns, the condition of the levels, and more particularly in reference to the water supply. The advocates of the pail and dry systems and other systems of that kind had been in the habit of pointing to those towns in which the water-closet system had been carried out with the intermittent water supply, and in which, probably, every time the service had been turned off, the sewage, as he knew to have been the case in many instances, had got into the water mains. When they took the case of a town without a water-closet system, and simply compared it with such a case as that, it must tell badly for the water-closet system. But that was not a fair comparison. They should compare a town in which the dry system was pursued with one in which the water-closet system was used with a constant supply of water. Those who took an interest in the statistics of the death-rate must have observed the change that had taken place in Liverpool. The sewer ventilation and the constant service of water supply were now extended to more than two-thirds of the inhabitants, and were doing a great deal for the town.

Mr. Gott (Bradford) expressed his surprise at hearing some Members of the Association say that certain questions had been settled; that was to say, that it had been decided that the water-carriage system for carrying away sewage was the best, and that some other modes of dealing with sewage by irrigation and otherwise had been settled. He had never heard of their having been settled, and he was quite sure that many other Engineers of extensive practice were not aware of it; because it was well known that there were great differences of opinion on those questions; and why anyone should say that they had been settled he could not conceive. Perhaps if some Members who thought so would extend their observations to some of the large inland towns, where the whole town was surrounded by a chalky soil, or was, perhaps, situated in a valley where it was impossible to get flat land for the purpose of irrigation, or where other difficulties were presented by the configuration of the ground, they might change their opinions. If anyone could point out within twenty miles of Bradford a spot that would answer for the purposes of sewage it would be a great relief. The question could not be treated as one that had been settled in any sense whatever. It might be very well for small towns where

there was no manufacturing refuse to dispose of, but merely house drainage. It would take an immense district of land to dispose of the sewage of Bradford by irrigation, of which but the smallest portion would be of any use to the land. Any advantage derived from it would be more than counterbalanced by the mischief done by the refuse water from the manufactories, which not only contained no manure, but the very opposite of anything that one would desire to put on the land. In Bradford they did try to deal with the sewage by some precipitation and filtration works. The corporation entered into an arrangement with a company, who thought they had found out a process by which the sewage could be dealt with. They tried very hard. Something like 100,000*l.* was spent by the corporation in making works and trying experiments to work out the process; but no profit resulting, the company, as might readily be seen, could not carry on the work. Having spent most of their capital they could not raise fresh capital, and they were obliged to abandon the undertaking. That led to the abandonment not only of the works but of the process. It was the filtration of sewage through peat charcoal. He did not believe that the process of filtration could be successfully applied to large towns. The question of the removal of town refuse, he believed, had been discussed considerably. He had been much pleased indeed to hear the remarks made by Dr. Leigh, and he was convinced that some good had been done, and considerable progress made in dealing with the solid refuse that must arise in large towns. It was all very well to say that water-carriage would answer that purpose, but it would not answer the purpose in view where large quantities of town refuse were to be disposed of. Some provision of the kind described by Dr. Leigh was, he was sure, necessary, and if it could be so managed that they could collect the fæcal matter that arose in the towns, and make it available to dispose of as manure, it appeared to him that a considerable step would be made in the right direction.

Mr. Fowler (Salford), in replying to the remarks made on his paper, said the system he had advanced had met with more approval than he had at first thought it would meet with. He had heard much said against it so far, but, on the other hand, he had great approval from practical men, which was very important in dealing with such a question. Some remarks had been made as to what he had said about the twopence per thousand gallons in Salford, but in Leeds, where he had been engaged on the waterworks, they raised

the water 240 feet, including the cost of coals, capital, &c., at one penny per thousand gallons.

A Member: It was understood here that you put it at a cost to the Corporation of Salford of twopence per thousand gallons.

Mr. Fowler explained that in Salford the effluent water flowing from the tanks could be pumped up and sent to the Pendleton hills at a cost of twopence per thousand gallons, and distributed at a cost of a halfpenny. Such effluent water in Salford, at threepence per thousand gallons, would answer for all sanitary purposes. The system of the tanks was self-acting, and did not require any more water than would come from bedroom refuse and slop water. Mr. Ellice-Clark said they paid a shilling per thousand gallons in Ramsgate, but he did not say that water could not be had in other places for less than that. If they took the water from sewage wells, they would be able to save the picked waters from the tributaries of the large rivers. They saw every day, by the Bills before Parliament, that a corporation no sooner got one waterworks scheme finished, than it went to Parliament with another Bill for a further supply, and the demand for water was daily becoming more important. It had been said by some who supported Dr. Leigh's views, that if that system could be carried out a great saving would be the result; but when all the material was collected together in a heap, where was it put? It was in the centre of a population still, only that instead of being in one heap before being collected, it was spread all over the town. The arguments brought to bear on the subject showed that the material could be sold only at a certain time of the year, and therefore for five or six months in the year there must be a store of it. Take it in hot weather, with a fall of rain on it, and see what the result would be. Could they put it among the rich if it was a nuisance? Put it among those who had capital and influence and power, and see what they would say to it. They would not put up with it for a moment. Let the stuff be taken to the poorest districts of the town, and then see whether the people would say it was no nuisance. One might go near the place with his eyes shut, and his sense of smell would soon tell him where it was.

Mr. Elcock, in replying, said the drift of his paper was more to show how the refuse of towns could be got rid of, than to do away with water-closets and to substitute the dry-earth or pail system. Neither the dry-earth nor pail system was part of the system that he advocated. His object was to show how those great heaps that

the Salford surveyor had just spoken of might be reduced in bulk, and, instead of becoming the festering mass which he had described in hot weather, become perfectly inodorous and impossible to putrefy. It must be confessed by everybody that if those heaps were converted into charcoal, let them be as high as they might, they could not give out infectious gases, as the other matter did. Further, there was no great market for the rubbish just as it lay in the way it did, for it must lie some months before a farmer would put it on his land under any consideration, whereas, under his (Mr. Elcock's) system, by reducing the whole mass to charcoal, they could put it on the land at once. Of course, where there was not a pail system in vogue, there were sure to be privies as well as slaughter-houses, and a deodorant was wanted there. He had heard of as much as 28*l.* a ton being offered in Salford for a deodorant, whereas they had at his works an effectual deodorant at 5*l.* a ton. The dry system did not mean that there were to be no sewers, because a town could not get on without sewers, and therefore the system he had laid before the Association did not at all imply that towns were to have reeking, festering masses in their midst through there being no sewers. Mr. Elcock then explained the construction of his model, and said it was filtering at more than three times the rate at which any water was allowed to be filtered by any water company, that was, it was filtering at the rate of 100 gallons per square yard per hour. He did not let the water run more quickly, because it would all pass through before he had time to explain the system, but as he now let it pass through more quickly, the filtration was going on at the rate of 200 gallons per square yard per hour. The model contained five samples of charcoal. One was made from the mixture of street sweepings with common coal; another sample was made from the street sweepings themselves; another was the same charcoal ground fine; and another was made entirely from the dust-bin refuse. In another compartment was a mixture of street-sweeping charcoal and night-soil, and that specimen contained 50 per cent. of night-soil at least. Mention had been made by Mr. Vawser of an offer made of some works by him for a trial of this process. He was under the impression that Mr. Vawser was quite as well aware as himself that the proposal had not been lost sight of, and steps had been taken to avail of it. He hoped before long to be able to do so, and that at the next meeting he would be able to report on what had been done. Mr. Elcock, in conclusion, pointed

out that the water, after passing through his machine, was perfectly clean and pure.

Major-General Scott said, in reference to the disposal of sewage and the supposition that the question had been settled long ago in favour of the water-carriage system, he believed that if the general opinions of the engineers, from the north as well as the south, were taken, none of them would be found to be far wrong as to the real state of the case. He thought all would feel that the ultimate destination for the sewage matter was the land. All would agree that there were many cases in which the sewage, without taking out the solid matter, could be placed on the land. He supposed every one of them perfectly agreed that if they could have the water-closet system they would never use the pail system, but he could not think that when they had the pail system it was necessary that they should have such an amount of filthy sludge as had been spoken of that day. For instance, he had been in Rochdale three or four times, and he had passed the carts in the streets carrying the pails, and they were so carefully protected that he could detect no nuisance. He did not think the works themselves even were so great a nuisance as a tanner's yard. He believed there was a great deal of sentimental talk about this question that really had more influence than it should. If the same attention were bestowed on the dry system that had been bestowed on the water-closets, he believed there would be a much more convenient form of privies than existed at present. A great deal had been done, and many of the dry closets could be used without nuisance or inconvenience to anyone.

The President said they were very much obliged to the gentlemen who had taken the trouble to prepare papers for them. So far as the sewage was concerned, they might consider the discussion at an end.

Mr. Angell (Past President) proposed a vote of thanks to those visitors who had read papers before the Association.

Mr. Lemon (Vice-President) seconded the motion, which was passed.

This concluded the first day's proceedings.

ANNUAL DINNER.

The Members of the Association and their friends dined together at the Queen's Hotel, Manchester, at the end of the first day's proceedings. The chair was occupied by Mr. J. G. Lynde, City Surveyor of Manchester, President of the Association.

After the usual loyal toasts—

The President said he now came to a toast in connection with a subject that more immediately concerned them as an Association. He alluded to "The Municipal Institutions of our Country." These he believed formed one of the greatest safeguards of our Constitution. They afforded to everyone an opportunity of having a voice in the management of those public matters which most intimately concerned his personal welfare. In fact, local self-government had, in his opinion, preserved them from many of the evils that they had witnessed in other countries, where the whole of their affairs had been under the direct management or influence of a central authority. The local authority could alone have that intimate knowledge of the wants of the district which rendered it most capable of dealing with them; and, so far as his experience went, there appeared to be only one desire on the part of such bodies, and that was the promotion of the welfare of the people within their jurisdiction. He had therefore much pleasure in proposing "The Municipal Institutions of our Country," coupled with the name of the Mayor of Manchester.

The Mayor of Manchester, in responding to the toast, said he was, in the first place, to thank the President on behalf of the municipal institutions of the country for having proposed this toast in such a complimentary manner as he had done, and he also thanked those present for the enthusiastic manner in which they responded. He believed, as the President had stated, that the municipal institutions of this country were of the greatest value, and they were, as a rule, doing an immense amount of good in the country, and he (the Mayor) believed, as a rule, the gentlemen comprising them were giving themselves to their work with an earnest desire to do the best they could irrespective of individuals.

He supposed that every one of the gentlemen present represented some municipal body or local board, and they would be able to know from their own experience—and he had no doubt they would confirm what he had stated—that there was an earnest desire throughout the country on the part of those bodies to do their duty. He considered, as the President also did, that it would be a great disaster to this country if the originating power of our local governments were to be taken away from us and be centralized too much in London. We had witnessed this to a considerable extent in other countries, and many were alarmed in the early part of the Session by the appearance in bills before Parliament of an increasing tendency towards centralization. Whether these bills originated in the minds of the statesmen who proposed them, or were acts of the subordinates, mistaking the wishes of the ratepayers, he did not know, but he thought they were very much indebted to the various associations and corporations for the steps they had taken, by which a very large proportion of the evil that had been dreaded had been removed. He thanked the company on behalf of the municipal institutions of the country, and of Manchester particularly, for the honours with which they had received the toast.

The Mayor of Manchester said that, with the permission of the President, he would propose the next toast, and that was "The Association of Municipal and Sanitary Engineers and Surveyors," who were assembled in Manchester that day, and whose guest he had the honour of being that evening. He looked upon it that those gentlemen by their coming there that day had shown the earnestness with which they were endeavouring to do their part in the work of assisting the Corporation to do theirs. It was a very gratifying thing to hear them that day. It was true that the public generally had still a great deal to learn with regard to sanitary matters, and they would look forward in a few years for something very valuable from the work of that Association. He could not help thinking that there was a class of municipal officers who should be associated with the municipal surveyors in their work, and with whom they came in contact in the course of their daily business,—he referred to the medical officers of health. However, that was a matter for the borough surveyors themselves. He would propose "The Association of Municipal Surveyors," coupling the toast with "The name of the worthy President," of whom he could not speak too highly as the City Surveyor of Manchester (applause), whom the Corporation had at all times

found equal to any occasion, and whose appointment they had never regretted since they had made it.

The PRESIDENT, in responding, said he had to thank them most cordially for the very kind and hearty manner in which the toast had been proposed and responded to. The Association is yet in its infancy, this being only the third year of its existence, but it had been hailed from all parts of the country as something that was wanted to enable them to develope the power within them of advancing sanitary science; a power they felt they must possess in consequence of the large amount of practical knowledge they had acquired, but which was to a great extent unutilized for the want of co-operation and intercourse amongst their Members. This Association afforded the means of interchanging their ideas and profiting by the accumulated experience of all their Members. This would be of value, not only by increasing their own stock of knowledge, but it would be of considerable advantage to the municipal bodies for whom they acted, inasmuch as it enabled them to bring a large stock of experience to bear upon their works, which they could not otherwise obtain. If they continued to pursue that as their principal object, they would, he felt sure, continue to receive the support and assistance of the local authorities, and it was to this they must look for their future success; for it was only by having one mind and one will with those gentlemen, whose views it was their duty to carry out, that they could hold their positions with satisfaction to themselves or with advantage to the public. He could only say that he had uniformly met with kindness and support from the Corporation of the city of Manchester, for whom he had had the honour of acting for nearly eighteen years, and he had no doubt most, if not all, of them had had a similar experience. Let them then continue to work heartily with their respective local authorities, and do all in their power to foster the good feeling that rendered their labours easy to them and their work a pleasure. If they all did that he was sure they would not hear so much of the outcry for Government protection, which he always protested against, and which had, in his opinion, been so wisely denied to them. He had to thank the Mayor, not only for giving them the advantage of his presence during the more serious business of that day, but for joining them in their relaxation on that occasion, thus affording them a practical assurance that he approved of their objects and desired the success of their Association. He begged to thank the Mayor and

gentlemen for the kind wishes which they had expressed towards the Association and to himself as its President for the ensuing year.

The Hon. Secretary (Mr. C. Jones) said, he had been deputed that evening to take charge of a toast which he was sure would meet with the approval of all who were gathered there. He felt somewhat diffident in speaking on the subject that night in the presence of persons holding such distinguished positions amongst them; at the same time, as a matter of duty, he took up the toast that had been put into his hands, "The Municipal Officers." He did not know whether it was well that an officer of such humble degree as himself should be giving a toast referring to those holding such high positions in connection with municipal corporations throughout the country. A remark had just been made, and seemed to come with considerable force from the Mayor, who said, referring to the municipal corporations, that they were of enormous value to the country, and he thought he should not be going beyond the proper line of prudence in saying he felt that very much of the credit that attached to the municipal corporations arose to a considerable extent from the officers who had to do with them, from those officers who had filled their positions so honestly and so thoroughly as had the municipal officers of such towns as Manchester and Salford. Those were the two names on the paper he had just received in connection with the toast. When a gentleman who held the honoured position which their President held, could be referred to in such terms as the Mayor of Manchester had referred to him, they might all take honour from the fact, and enjoy somewhat the advantage of the light which reflected from him, as an officer for Manchester. But the name that was more particularly connected with this toast, was the name of Sir Joseph Heron, Town Clerk of Manchester. (Applause.) He felt sure it was only necessary to mention that name to call forth a united response from all assembled there; hence he did not hesitate to say if all the members of all the corporations throughout England were gathered together on that occasion, there would be but one response to the mention of Sir Joseph Heron's name. (Applause.) It had been whispered to him just that moment that the position which Manchester occupied amongst the large municipalities of the country was that of third, but as far as the name of its town clerk was concerned, it stood first. Manchester might stand third, but among the municipal officers,

Sir Joseph Heron stood first. (Hear, hear.) He spoke as one who for years had known Sir Joseph Heron's name, as all present had known him, and all acknowledged the good he was doing at the present time in connection with the various Parliamentary Bills. Sir Joseph was a power, and it was a great honour to have him with them. It would ill become him to say more in connection with the matter. Something was said about the Association being in its infancy; and again, something was said about Government protection. The two things went very well together, because he saw in the remark a way out of the difficulty at once of reconciling two differences of opinion. It was well when the Institution was in its infancy to have a little protection, but it had now arrived at the third year of its existence, and it was getting out of its leading strings; and they felt, here in Manchester, that they might step outside that line, and that it was perhaps not necessary that they should have any longer Government protection. He hoped therefore that the gentlemen who had spoken on that subject would shake hands on the matter. He had much pleasure in proposing "The Municipal Officers of Manchester and Salford," coupled with the name of Sir Joseph Heron.

The toast was responded to in the usual manner.

Sir Joseph Heron, in responding, said he hardly knew exactly where he was. Only for the last few words that were uttered by the speaker who had just sat down, he would have expected that when he stood up nearly the whole of the company would have stood up with him. He was glad that he had to reply for the "Municipal Officers of Manchester and Salford" only. It was fortunate for the other municipal officers present, because they would have been wearied and tired before they had the chance of sitting down, if they had to stand during his long oration. (Hear, and laughter.) It was a species of cruelty that people could not enjoy themselves at dinner without being subject to the disagreeable ordeal of having to make a speech afterwards. He hardly knew how to thank Mr. Jones for the complimentary way in which he proposed the toast, but especially for the very kind way in which he referred to himself (Sir Joseph Heron), and to the services that he had been able to render to the municipal corporations. There was one observation Mr. Jones had made, in which he (Sir Joseph Heron) entirely concurred. He was going to look around to see if, in the language of Burns,

"A chiel's amang ye takin' notes."

He always felt that those gentlemen (the reporters) generally showed more prudence and discretion than those whom they had to report. He should not feel alarmed at what might appear in the press next morning. He most entirely agreed with one observation made by his friend, Mr. Jones, who said, and he smiled when he said it, as though he thought he was scarcely authorized to make such an observation, that he would venture to refer the great efficiency of all municipal corporations to a great extent to their officers. That was an opinion in which he (Sir Joseph Heron) most entirely agreed (hear, hear, and laughter); and it was an opinion in which probably nearly all the gentlemen present, who were municipal officers, would to a very large extent coincide. But, joking apart, he meant it in all seriousness. The work of corporations, or of any other local authority whatever it may be, had to be done in fact by the executive. The officers were the all-important part of that system of government. It was all very well to have a handsome Mayor presiding over the municipal body. (Laughter.) They were very thankful indeed in Manchester to have a gentleman like his Worship, whom they could bring and show before the public (applause and laughter); but that was not the way in which the work was done. (Renewed applause.) They knew that it was the hard-working executive officers of the municipal corporations that gave to them a large share of their advantages and their power. He had been much interested in attending the meeting of that day, and he felt very much obliged to the Association for being so kind as to invite him to be present. The subjects of the various papers and discussions were such as he knew to be at the present time intensely interesting to all municipal corporations, and he might say to all local governments. He was not surprised to find that there were considerable differences of opinion in regard to the sewage question. He was rather amused by Mr. Ellice-Clark saying that afternoon that the thing was completely settled, because we had a Blue Book on the subject. (Applause and laughter.) Now, he must say that would be the last book he should think of referring to as an authority. We had certainly too many Blue Books, and we got report after report of one commission after another, and he declared that, as far as he was concerned, they left him pretty much where they found him. He believed that such associations as he had the honour of addressing were far more likely to lead to practical and valuable suggestions even than those to whom they might be supposed to look with

great deference. There was just one remark that he would venture to make. He thought that legislation ought to be very equally applied to all parties. He did not think it would be right to attempt to cast upon local authorities the terrible expense and responsibility of dealing with their sewage, unless at the same time the Government had the will and the power to deal with manufacturers and traders. (Applause.) It would be an invidious thing to put the ratepayers to the cost of keeping sewage out of rivers, and not to deal in the same manner with the filth and pollution which came from trades. He would rather wait and have the whole subject dealt with upon a right basis, than to see it dealt with partially, by dealing first with the corporations and afterwards with the manufacturers.

Mr. Angell (Past President) proposed the toast of "The Vice-President and Officers of the Association." He thought that it was appropriate that he should propose the toast, for he was sure no one knew more than himself how to appreciate its value, because, during the two years he had been President, he had been most cordially and ably assisted by the officers of the Association. Of course it was not only the President who did the work, he was in a position of honour, but it was really, after all, the officers of lesser degree, he meant the General and District Secretaries, who really worked out the details, and no great work could be carried out unless it was most carefully attended to in details. He had been most ably assisted in that way not only by Mr. Lemon, the Vice-President, but by the local secretaries, like their friend Mr. Vawser, the Local Secretary for this district. He had not only organized many good meetings in the north, but had managed all the details in working out the present most successful meeting. He had also received most valuable assistance from Mr. Pritchard, who had joined him from the very first, and had worked up the interest of the Association in the Midland Counties, where municipal officers were very numerous, and Mr. Pritchard had induced a large proportion of them to join and take an interest in it. Those gentlemen to whom he had referred took the greatest interest in the district meetings, which he felt was the real strength of the Association. There was also Mr. Ellice-Clark in the south, whose abilities and energy were only limited by his opportunities. In the north there was a nest of towns, and meetings could be held at short notice; in the south the towns were few and scattered, but Mr. Ellice-Clark had been of great service to the

Association, and had he been farther north he (Mr. Angell) had no doubt he would have been of still greater service. He could not conclude without mentioning especially the Hon. Sec., Mr. Jones. On Mr. Jones had fallen the heat and burthen of the day; he had to attend to all the general details, but he made his work a labour of love, and they could not be too thankful to him. He (Mr. Angell) spoke from the daily communications he had with Mr. Jones. It so happened that there had been an acquisition of strength that day. He was happy to see among the Vice-Presidents Mr. Deacon and Mr. Pritchard, but especially their old Vice-President, Mr. Lemon, whose name he was about to mention in connection with the toast. He gave "The Health of the Vice-Presidents and Officers of the Association," coupling the toast with the name of Mr. Lemon.

Mr. Lemon, in returning thanks, said that the Association would not expect very much from the President, as the work would chiefly devolve on the Vice-Presidents. He was very much pleased with the election of the Vice-Presidents. It turned out so happily that the three districts were represented by them. It had long been thought that the Association should have three Vice-Presidents, so that whenever they had a district meeting they would have a Vice-President representing each particular district. Whether that suggested the design of appointing three Vice-Presidents he could not tell, but it so happened they had Vice-Presidents who represented each district; so it had turned out a very happy arrangement, and he was sure the President would have a very prosperous year of office. He would receive great assistance from the officers during the year, who would do all they could to make his year of office a success.

Mr. Pritchard next responded. He said he had very great pleasure as one of the Vice-Presidents to offer a few remarks with reference to the toast which had been given in so kind a manner, and had also been received by the Members present. He could only say that it was the desire of every officer of the Association of Municipal and Sanitary Engineers to do all they could, not only by interchange of thought to assist each other, but also it should be their primary consideration to assist the municipal and other bodies with whom they had the honour of being connected. He thought he might safely say that there was no Member around that festive board who did not consider it his first duty to act honestly to his employers, whether they might be the municipal corporation of a

great city like Manchester, or whether they might be some local board or other authority. For himself he considered it a very great honour to hold the position of an officer to the Association, however humble it might be. When they had such an example before them as that shown by their late President (Mr. Angell), they might very fairly expect similar assistance from their present President. It really was an incentive to the junior officers of the Association to support the President by every means in their power.

Mr. Deacon next responded. He was under the impression that the senior Vice-President would have responded for all three, and he would have been more pleased had he done so, for he himself was rather ashamed to show his face before the Association, he had attended so badly to the work for the last eighteen months or so, but it was not because he had not taken an interest in the Association, but simply the private work he had to do completely prohibited him from attending as he would wish, and he hoped that during his Vice-Presidency he would be able to give more assistance to the work of the Society than he had done.

Major-General Scott proposed "The Health of the Past President, Mr. Angell." He said the task was a most agreeable one, and he was quite sure the toast would be received by the Association with great satisfaction and perfect enthusiasm. He was extremely pleased with the remark which Mr. Angell had made, which showed that he was a good general officer, namely, that all the praise which was due to the work of the Association was due not to him, but to the officers that were under him. He was quite sure that that Association was one that would work incalculable benefits throughout the country. Personally, he felt very much indebted to Mr. Angell for his kindness in inviting him to take part in the discussions of the conference, and he confessed there was nobody in the kingdom before whom he would rather bring any remarks he had to make in connection with sewage than before that body. (Hear, hear.) They had amongst them all the information that was necessary for a judgment on these points, but if the benefits which their work conferred on the country were, as he believed, incalculable, the difficulties they had to contend with were also incalculable. He was afraid he might be making a displeasing remark, but he was sure it would be received kindly. He regretted that they did not make the Association a wider one; that they had not included in it, but he hoped they would receive into it, not

only the medical officers of health but town clerks also. Sir Joseph Heron was not the first town clerk with knowledge on this subject whom he had had the pleasure of meeting, and he thought the Association would receive a great deal of valuable information from the reports of the medical officers and from the town clerks also. He would now give with all the honours "The Health of the Past President." He thought there was hardly any man in the kingdom who had done more at the present moment for the establishment of that body and for the welfare of the rising generation than Mr. Angell.

The toast was received with enthusiasm.

Mr. Angell, in responding, said he hardly knew how to thank his friends for the honour they had done him, for he looked upon the toast as much more than a formal compliment. He had taken an active part in the formation of the Association. It had occurred to him, that many officers of municipal bodies were scattered throughout the length and breadth of the country, who had a common object and interest, and that there ought to be communication and unity of purpose and action among them, and if he had tended in any way to promote that end, he was fully rewarded, indeed he had been more than rewarded by the honour that had been paid him. The Association had made him its first President, it retained him in that office during a second year, but more than all, and the greatest gratification he had received was in this, that they responded to his call—for he might have called in vain—and they had made the Association a success. The meeting of the Association that day proved that it had taken a position among the societies of the country. The observations of General Scott had shown that if they pretended to great success, there were also obligations on them. There was an ample field of work for them. The country was now awaking to the necessity for an improvement in its sanitary condition. The Government had at last awoke to the necessity of sanitary legislation, and it was the province of the Sanitary Engineers of the country to promote sanitary work in all practical details. That was the object of their Association and the object of their meeting at Manchester. He could not thank them too much for the honour they had done him in the past, and for the kind manner in which he had been spoken of that day. He could point to Mr. Lynde as one worthily representing Municipal Engineers, for out of London he did not know any officer who represented them so well by seniority and professional ability. Though the office of

President had passed from him, he hoped to meet Mr. Lynde and the Members on many future occasions; not only at their annual meetings, but in the district meetings which were the life and soul of the Association. When they met next year in London, he hoped to find the efficiency of the Association as great, and its position before the country as good as it was at the present time.

Mr. Fowler (of Salford) said, the toast put into his hands was that of "The District Secretaries." As Mr. Angell, the Past President, had referred to them in such eloquent terms, he felt a difficulty in finding words to express the congratulations which the Association owed to them. The Local Secretaries, as they were aware, were Mr. Vawser, of Warrington; Mr. Pritchard, of Warwick; Mr. Ellice-Clark, of Ramsgate; and Mr. Alty, of Keighley. The Association had been launched under great difficulties, and its success had been in a great measure due to the indefatigable work which they had done. He might say for Mr. Vawser, of whose ability he had had frequent opportunities of judging, that he must have sacrificed a large amount of time in going about the country and in bringing meetings to a successful issue. With regard to Mr. Pritchard, they all knew how well he had discharged his duties. He (Mr. Fowler) had not visited Mr. Pritchard since he had been a Member of the Association, but they read from the accounts in the papers how very ably the meetings had been conducted. With regard to Mr. Ellice-Clark, he could echo the same good opinion which they all felt respecting him. With respect to Mr. Alty, his was a young district so to speak, but taking them altogether he was sure that the Association was greatly indebted to those gentlemen for the labours they had bestowed in endeavouring to bring the Association to a successful issue. No doubt to Mr. Angell was due the crowning success of the work, but to the manipulation of the business by the Secretaries he thought a great deal of its success was also due. In some localities in England, if more energy had been bestowed on the work, he thought they would have had a larger number of Members, but in the Lancashire and Cheshire districts the work had been carried on with great *éclat*, because Members adhered in greater numbers than in any other district in the country. He proposed "The Health of the Local Secretaries," coupling with it the name of Mr. Vawser.

Mr. Vawser responded. He said it would be false modesty to attempt to deny that there was a great deal of work in connection with the office he held. Previous speakers had already referred to

the fact that a great part of the actual work of organizing the Association and keeping it in working order devolved on the Secretaries. There had been a great deal of trouble about that meeting, there was not the slightest doubt, but he could say he fully appreciated the kindness which had been shown to him in proposing his health to the fullest extent. The object of the Association was not altogether to confer honours and drink toasts, and pat each other on the back, but it was for the one practical purpose for which they had met that day, namely, to read practical papers and discuss practical questions. He looked upon the Association as a means of giving and receiving information, and enabling them to know each other. There was no one more indebted to his colleagues—to men occupying similar positions in towns, than he was. Whenever he sought to obtain information from other towns he had always had it granted to him with the utmost cordiality. If the other Members present would make it a point of attending the district meetings in connection with the Association in different parts of the country, and consulting with each other, it would be very much to their own interest and to the interest of their employers. He was very glad indeed to find that the corporations of the different towns were far from looking on this Association with any feeling of jealousy, but, on the contrary, were assisting them; in fact, the corporation which he represented undertook to pay his expenses to the different meetings which he attended, a very proper step, perhaps, because they knew very well the information which he was able to get at the different places was for their advantage and not for his own. He was thankful for his health having been proposed, but he would rather not reply on behalf of those other Secretaries who were present. His friend, Mr. Pritchard, had already been promoted to a higher office, and he thought the other secretaries might take that as a sample of the good things that were in store for them. (Hear, hear, and laughter.) In due time, no doubt, Mr. Pritchard would be President, and he was not without hope that he might be so himself. (Hear, and laughter.)

Mr. Ellice-Clark responded. He was perhaps the youngest Member, and had received the largest benefit. When he joined the Association he was quite a fledgeling, he had not been a local board Surveyor more than three days (hear, hear), and therefore whatever benefits he had received from the Association he was most grateful for. One or two gentlemen had given him the name of "teazer," because he had teazed them with questions upon many

important things that concerned them all, but the questions which he wrote and sent round to the Members had been numerous, and long and difficult to answer, and he must say, that out of nearly two hundred queries which he had sent round, and of which the answers contained the most valuable information, fully 90 per cent. had been answered most fully, and that would show those Surveyors who had not yet joined the Association what a valuable Institution it was, at all events to such young Members as himself. He assured them, for what little trouble he had had with the Association, he had been most amply repaid by their kindness and, he must say, by the most courteous manner in which Members had always responded to the questions he had asked them in the way of professional advice, of which such young men as himself were constantly in need.

Mr. Deacon (of Liverpool) proposed the toast of "The Visitors," and said he had much pleasure in doing so. The task was not an arduous one, from the fact that, directly or indirectly, the toast of the visitors had been proposed three times that night. He knew that the real usefulness of the Association would be felt and believed in by the corporations which they represented, in proportion as they asked members of those corporations, and especially members of such corporations as that of Manchester, to come among them as visitors and know what they were doing. He knew that the feeling at first was to exclude from the meetings all except the Members of the Association, but he believed a greater mistake could not have been made, and he thought a great part of the usefulness of the Institution would have been thereby lost. He begged to propose "The Visitors," coupling it with the name of Mr. Councillor Schofield.

Mr. Councillor Schofield, in responding to the toast, said that he had no doubt that the Members of the Association would find, as the people of Manchester themselves found, that the corporations were made up of a great mixture of men. They had men of strong sense, men of middle sense, men of only little sense, men of good ability, and men of very little ability. They had men of common sense, but they had one class of men in particular in whom he was sure municipal officers generally felt a great interest. They had men who called themselves economists, and their economy consisted in cutting down as much as possible the salaries of the officers. They thought that if they could cut down a salary by 50*l.* or 100*l.* a year, that was a great economy; but still, on the whole, there

prevailed in the corporation a great deal of good practical sense. There was nothing showed more strongly the good sense which prevailed in the corporation than the officials appointed. Among the officers and officials of the Manchester Corporation they had the President of the Association, Mr. Lynde; also Sir Joseph Heron; and Dr. Leigh, the officer of health, and he thought that those appointments spoke strongly in favour of the Manchester Corporation. He must say that it seemed to him, that not only in Manchester, but in all other corporations, seeing the muster of gentlemen assembled there that evening, the same good practical sense characterized them all. There was no doubt that such meetings as that, where gentlemen canvassed sanitary matters and talked them over with one another, would help to bring on gradually some sort of a solution as to what is the best to be done. He thanked them for the invitation and for the honour in which they had received the toast.

Mr. Ellice-Clark proposed the health of the ladies, which was responded to by Mr. Vawser, after which the company separated.

SECOND DAY'S PROCEEDINGS.

FRIDAY, JULY 2, 1875.

THE second day's Meeting was held in the Mayor's Parlour, Town Hall, Manchester. Mr. J. G. LYNDE, President, in the chair.

The proceedings commenced with a Paper on

STONE-BREAKING MACHINERY.

BY MR. ARTHUR JACOB, B.A., M. INST. C.E., BOROUGH ENGINEER, BARROW-IN-FURNESS.

THERE is hardly a town or district in England, not excepting the metropolis, in which a greater or less extent of the highways is not repaired by broken stone, or macadam, as it is now sometimes called. It is therefore a matter of importance that the greatest economy should be exercised in the production of the material to be employed. Manual labour is becoming more expensive and less easy to manage every succeeding year, and the introduction of machinery into all departments of engineering is consequently more than ever desirable. It is, indeed, a matter of surprise that hand labour has not long since become obsolete for such a purpose as stone breaking.

It is proposed to confine the following remarks to the application of machinery to the breaking of stone for the repair of roads, though, of course, stone-breakers have been for some years employed in mining operations for the preparation of the limestone used in smelting and for other purposes. So far as the writer is aware, there is no information on record as to the actual cost at which stone can be broken by machinery, with the exception of statements made by manufacturers of stone-breaking machines, and such statements are usually of little value, being probably based upon experiments and trials which would furnish no sound estimate of the performance of the machine when in ordinary use.

Before deciding upon the employment of machinery in substitu-

tion for manual labour, it is necessary to determine whether, taking interest on the first cost of the plant, with wear and tear and working expenses, the expense of production will bear favourable comparison with the price of manual labour; and it is hoped that this memorandum may be of some practical use to those who have not yet had to consider the subject, in showing from actual results the relative advantages of machinery and manual labour.

There are, so far as the writer has been able to learn, four kinds of stone-breaking machines in use; but that which appears to be most general is known as Blake's patent, the details of which are probably well known to most Members of this Association. The machine consists of a massive cast-iron frame, inside one end of which is fastened what is called the "fixed jaw." Opposite to this, and only a few inches distant, is suspended a heavy movable jaw, to which a horizontal motion is imparted by a vertical arm, called the pitman or connecting rod, which receives an up-and-down motion from an eccentric. The vertical motion is communicated to the movable jaw by toggle-plates, which fit into grooves in the connecting rod and in the back of the jaw; so that the jaw opens and closes at each revolution of the fly-wheels, or about two hundred times in a minute. Below the machine and at one end of it is a revolving screen, fixed at a certain inclination, into which the broken material passes from between the jaws.

This screen separates the fine material, of which there is necessarily a certain proportion, from the road metal which passes through the larger holes; and such pieces as are too large to drop through the holes pass down the cylinder and out at the end. The machine of which the following working details are given is one of the 9×15 size, these dimensions representing the opening between the jaws into which the stone is thrown. The engine employed for driving the stone-breaker is a portable horizontal engine, of the ordinary type of 8 horse-power. It is fixed on the ground level upon two horizontal balks of timber, the wheels having been removed to moderate the vibration. The stone-breaker is fixed at a higher level, in order to reduce manual labour as much as possible, and allow the broken stone to fall into wheelbarrows or into railway waggons which stand at the adjoining siding. The height and position at which a stone-breaker should be fixed will depend upon special circumstances. At Barrow the supply of stone for road making and repairs is delivered in vessels, which lie at the adjoining wharf, and are unloaded by a steam-crane, and

thus the stone is delivered in buckets direct to the machine; but it is evident that where the stone is to be procured from a quarry, it may be advisable to erect the machinery within the quarry, in such a situation that the supply and delivery may be effected with still greater economy, by simply running the rough stone down to the stone-breaker by movable troughs or channels of iron or timber, direct from the point where it is quarried. The stone-breaker is supported upon two trestles constructed of whole timbers, and is braced and strutted with all the care necessary to support a mass weighing from six to seven tons, and to prevent vibration as far as possible. A platform or flooring is erected at the level of the top of the stone-breaker, and a second staging underneath, at such a height that wheelbarrows can be conveniently placed below the cylindrical screen to receive the stone and fine grit. The upper staging is furnished with a handrail for the security of the workmen, and the lower one, which is necessarily under cover, is screened off on the weather side by boarding, to protect the men whose duty it is to remove the stone from the inconvenience that the grit and stone-dust would cause them if the lower staging was exposed to the wind. The stone-breaker, engine, and crane are situated close to a wharf outside the dock entrance, and immediately adjoining a private siding belonging to the Corporation. This site was selected owing to the fact that the district immediately adjoining Barrow does not afford any very suitable stone for road repairs, and with a view to securing a supply from Wales, the Isle of Man, or Ireland; but for the present an abundant supply of greenstone, in the form of boulders or cobbles, is procured from the sea beach below Walney Island. The steam-crane delivers the stone in buckets direct from the hold of the vessel and hoists it to the upper platform, where the foreman of the gang takes his stand. By releasing a catch the bucket tips over and delivers its contents upon the platform, the surface of which is inclined on two sides, so as to facilitate the feeding of the stone-breaker.

Two labourers are employed for feeding, one to draw the stone down and the other to shovel it into the hopper. It is necessary to exercise some care in feeding the machine, so as to produce uniformity of work, and give the machine at all times a sufficient supply, without allowing an undue quantity of stone to lie on the hopper at any time. Below the upper platform two men are employed in removing the stone and grit from the cylinders, and wheeling them clear of the machine to their respective dépôts.

These men can wheel the stone to a distance of from 16 to 20 yards and keep the machine clear, but beyond that distance additional labour becomes necessary, and in this respect it is not economical to accumulate a large stock.

The following is then the staff employed for supplying and working the machine: One foreman; one engine-driver for portable engine; one engine-driver for steam-crane; two men to feed the stone-breaker; two men to deliver the stone; and one boy to stand on the quay side and signal to the man at the crane when unloading.

There is necessarily some variation in the weight of stone that the machine will break in the course of the day, the amount depending on the quality and size of the material to be dealt with and the condition of the jaws, which when new, as a matter of course, produce the best results. Feeding the machine, however, with stones varying from 4 inches to 6 inches in diameter, the average day's work has always equalled 60 tons, whilst it has often exceeded that amount, and on several occasions 80 tons of hard stone have been broken in the day. It will, however, be sufficient to take the average work of the machine at 60 tons, in order to arrive at a fair estimate of its economy. The working expenses are as follows:

	£	s.	d.
Manual labour	1	12	8
Coal for two engines, 12 cwt., at 17*s.* 6*d.*	0	10	6
Oil, tallow, and waste	0	1	2
Repairs of stone-breaker, and wear and tear of engines, say 15 per cent. on first cost	0	14	8
Contingencies, say	0	1	0
	£3	0	0

So that, taking every expense into account, the unloading of the vessels included, the cost of breaking a very hard and tough stone is as nearly as possible one shilling a ton. Blake's machines are credited with breaking stone at a much less cost than this, but if they do so, and there is no reason to doubt the statement, there will be conditions forthcoming to account for the difference in cost. As before observed, a saving of labour can be effected by delivering the stone direct to the machine by its own gravity, or the stone may not be required of so small a size as road metal. The above estimate, however, is based on actual results, and so far may be regarded as reliable.

It is hardly necessary to remark, that the cost of breaking stone

by manual labour will greatly exceed one shilling per ton. Indeed the ruling price for ordinary quarried stone, consisting of such pieces as the breaking machine can deal with, varies from two shillings to two and sixpence per ton; under any circumstances, when the requirements of a district are great, a stone-breaking machine is almost indispensable, as the amount of labour to be obtained as a substitute is generally very limited.

It is but fair, while giving full credit to the patentee for the efficiency of the machine, to point out some of its imperfections, or rather to suggest certain improvements which an experience of eighteen months' fair work had demonstrated. The machine was set up in exact accordance with the instructions furnished by the manufacturer, and when first put in operation it was found that the screen did not revolve with sufficient speed to get rid of the stone that passed through the hopper. In fact, the stone and grit collected in the upper end of the screen in such quantity that the work had to be discontinued. The screen is driven by a belt, which passes over a pinion on the same axis as the fly-wheel of the machine. This pinion it was found necessary to enlarge, which was done tentatively from 4 inches to 7 inches in diameter, and this increase gave the screen a speed proportional to the rate at which it was found practicable and economical to feed the machine. No doubt the velocity at which the screen at first moved would have been sufficient had the rate of feeding been slower, but the utility of the machine would have been impaired to a serious extent by feeding at a less rate than six tons per hour, the amount of stone now generally broken. It was found necessary to remove the wire netting, which occupied the first length of the screen, so as to let the grit escape more rapidly; and when making a new screen, the proportion of length occupied by large holes was increased by taking 1 foot of the space originally occupied by the small perforations; and a further length of 2 feet was added to the whole. The screen now in use is 9 feet long, 7 feet being perforated with large holes $2\frac{1}{2}$ inches diameter, and 2 feet with smaller ones $\frac{3}{4}$ inch diameter. The usual rate at which the engine is driven is 125 revolutions per minute, which produces 208 revolutions of the stone-breaker and 17 of the screen.

The proportion of grit to useful stone for road repairs will vary somewhat with the quality of the material employed, but stone of average toughness will yield about 1 cubic yard of fine material to 5 cubic yards of road metal; and in this respect the process

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might appear wasteful, but really it has not been found to be, so as there is full demand for the grit for paving and asphalting.

Usually the operations of machinery are attended with more perfect results than hand labour can produce; but the machine here described is an exception to the rule, as all who have used it will admit. The metal produced is not by any means as cubical or uniform in size as can be produced by hand. The jaws of the machine are fluted vertically, and when a large stone is placed between them it is first cut into two or three pieces, which, owing to the reduction in size, fall lower down, and are again divided until the pieces are sufficiently small to pass into the screen. This cutting process necessarily produces a certain amount of flaky and oblong stones, which do not result from hand labour; by which even slate and shale can be broken into tolerably cubical pieces.

Whatever stone is employed, a certain quantity will inevitably pass through the jaws either too long or too thin to use for road repairs, and though the greater number of such stones slide down the screen and do not fall through the holes, it becomes necessary to pass them a second time through the jaws; and no doubt many pieces get through several times before they are reduced to the proper size for use. The proportion of stone that has to be passed through the machine a second time is about one-eighth of the whole quantity, and with a slaty material no doubt the proportion will be greater.

An attempt has been made in what is called the cubing jaw to produce a form of profile in the movable jaw, which will enable it to catch the long and thin pieces of stone, and break them across before they fall into the screen, but though the idea is sound in principle it does not in practice offer any advantage over the ordinary fluted jaw. The cubing surface presents so many angles and points that that part of the jaw is worn away, and becomes hollow long before the ordinary fluting, and so far from the so-called improvement being of utility, it appears to be inferior to the ordinary corrugations in effect and durability.

It is hardly a matter of surprise that the wear and tear in these machines is as great as it is, when the work they perform is taken into consideration. During the last twelve months the following parts had to be replaced: Loose jaw, seven times; fast jaw, eight times; cylindrical screen, once; toggle-plates, four times; and side cheeks, six times. The actual repairs of the stone-breaker have

consequently cost for the twelve months, 124*l.*, and represents 62½ per cent. of the original price of the machine.

The quality of the material to be used in the jaws is a matter of the first importance, for their breakage is attended in more ways than one with expense; when a jaw gives way it does so suddenly, and the whole gang of labourers is thrown out of work until the broken part can be replaced. It is usual to keep duplicate pieces in readiness, but the removal of such heavy castings as the jaws cannot be effected without a delay of some hours.

The cause of breakage is a matter which is open to speculation. If a jaw be worn down, it is easy to understand that it gives way from loss of substance, but on more than one occasion it was found that after a pair of jaws had been at work for a few days, one of them, either the loose or the fast, has broken without any undue strain. It is not improbable that the immediate cause of the fracture was an altered condition of the crystalline structure of the metal, or having regard to the fact that during an average life of six weeks, a jaw receives no less than four and a half million blows at sufficient power to crush the hardest stone, possibly the fracture may be due to fatigue.

A few remarks on one or two other kinds of machines will not be altogether out of place, though their recognition is not so general as the one just described.

A machine known as Archer's patent consists of a cast-iron frame, at one end of which is fixed a roller which revolves on a horizontal axis. The roller is corrugated or fluted on the outside in the direction of the axis; against the roller a stout horizontal lever with two jaws is made to act so that the jaws press alternately above and below on the roller. The jaws are corrugated on the face that comes in contact with the roller, but in a direction transverse to the fluting upon it, an arrangement that is stated to have the effect of cutting the material into cubical and uniform pieces. The lever receives its motion from a crank, and is driven by an independent engine in the usual way.

The form of stone-breaker being exhibited at present in the Leeds Exhibition has been designed by Messrs. Ellison, of Wakefield: it consists of a vertical cylinder combined with a cone, which is also vertical, and mounted slightly eccentrically to the cylinder. The cylinder is driven by a horizontal shaft, upon which are keyed two fly-wheels and a drum, so that the machine may be driven by an independent engine. The conical block is so fixed that it will

revolve by the frictional contact of the stones, but it is not driven by direct gearing.

The stones which are filled in at the top gradually work down, being broken smaller and smaller until they fall out at the bottom. The width of the opening can be increased or diminished by raising or lowering the cone and the size of the material so adjusted. The manufacturers of this stone-breaker claim for it the speciality of breaking the stone into a more cubical form than any other machine will do: if this qualification is borne out in actual practice, the machine will prove a valuable one for the purpose for which it is designed. This machine can be used for triturating lime, cement, and other substances by altering the motion and driving the cone instead of the cylinder.

DESCRIPTION OF A STONE-DRESSING MACHINE.

By H. ROYLE, Town Surveyor, Hulme.

Previous to the inspection of the stone-dressing machine belonging to the Hulme Township of the Manchester Corporation, a brief description I now submit to the Association, stating amongst other particulars its cost, and comparing the work it performs against that of hand labour.

The machine is patented by Messrs. Coulter, Harpin, and Co., of Brockholes and Dewsbury, Yorkshire.

The action of this machine in many respects bears a resemblance to an iron planing machine; it is driven by a 6 horse-power horizontal steam-engine, connected with driving pulleys 27 inches in diameter, having a 5-inch cog-wheel working into another of 60 inches in diameter; the cutting tools are fixed in a cross-head, which is of considerable weight, to enable the tools to bite, inasmuch as there is no other pressure exerted. These tools are of cast steel $1'' \times 1\frac{1}{8}''$ square, some punch pointed, and others boasters, being serrated, and are wedged into position at an angle of 45°. These tools are raised or lowered by a screw motion sliding in side frames. The cross-head has a self-acting reversible crab motion, turning over at the end of the stone undergoing operation, and is prevented from bumping when falling into position by an air chest. The horizontal position of the tools is regulated by a quick screw motion by the man in charge. The stone is first placed upon a table 12 feet long, which slides on rollers upon a pair of rails, and is moved forwards and backwards by a 7-inch cog fixed to the driving shaft. The largest stone which can be worked is 9 feet long by 3 feet in width, and up to 3 feet in thickness. The stone resting on the table is held in position by a couple of screw-jaws having wooden teeth.

The machine is capable of doing a variety of stone work

such as ashlar, copings, sills, steps, and mouldings, which may be inspected.

The principal purpose for which the machine has been erected is for facing flags and curbs, which are obtained from the Rochdale and Rawtenstall districts, near Manchester, and are of the second or flag-rock of the millstone grit series. The upper beds are worked with ease, but the lower, or best rock, with difficulty, being extremely hard and compact.

The cost of the machine was 260*l.*; engine, 48*l.*; shafting and gearing, 28*l.*; not including carriage from the makers. The boiler, shed, tools, and foundation and grindstone, increased the amount by 224*l.*, making a total outlay of 560*l.*

If this be calculated at 8 per cent. for interest and depreciation, the annual cost will be 44*l.* 16*s.*; and estimating this sum at three hundred working days in the year,

	s.	*d.*	
The cost equals	3	0	a day.
Fuel	3	6	„
Tool sharpening and oil	1	6	„
Labour (2 men)	8	0	„
Being a total daily expenditure of	16	0	

The average quantity of flags faced is 20 square yards a day, which is equal to about 9½*d.* a yard; and comparing this against hand labour, there is a saving of about 2½*d.* a yard, at the same time the work is superior.

It may be added that the power employed is sufficient for two machines, and obviously if two were at work the cost per yard would be reduced to one-half of that of hand labour.

Addenda.—Since the above was written, the Corporation have erected one of Blake's 6″ × 3″ small stone-breakers, at a cost of 47*l.*, for the purpose of breaking up masons' scabblings and other hard material to pass through a 1″ screen (which was formerly carted away as rubbish). This material is used for paving purposes, for placing between the joints of the sets when asphalted.

By the erection of this breaker, and taking off half of the working expenses, &c., of the stone-dresser, the result is a nett gain of 17*s.* 9*d.* a day over the value of the material made, also a reduction in the cost of facing flags from 9½*d.* to 5*d.* per square yard.

The following particulars are appended:

		£	s.	d.
4 tons of pebbles made per day at 7s. per ton ..	=	1	8	0
1 load of fine stuff for gravel	=	0	3	0
Value of non-removal of 5 tons of rubbish at 1s. 3d.	=	0	6	3
		1	17	3
The daily expenses attending the breaker are 11 6				
Allow one-half of cost for working expenses, interest, and depreciation of stone-dressing machinery 8 0				
		0	19	6
Being a total gain of		0	17	9

after allowing 5*d.* a yard for facing flags; should even this charge be taken off, by considering they were faced without cost, there is still a balance of 9*s.* 5*d.* left to the credit of machinery.

DISCUSSION.

Mr. Lemon (Vice-President) objected to stone breaking by machinery, on the ground that his experience showed him that the stones broken were not uniform in size, and they knew that one of the principles of a macadamized road was that all the stones should be uniform in size. He had formed a very high opinion of a machine like that described by Mr. Jacob, and he believed he should have purchased it, but unfortunately, during the experiment, a piece of stone flew out and struck the man attending it on the head and killed him. Of course an accident like that threw a damper on the case. He thought the machine a very excellent one; it reduced the cost considerably, as Mr. Jacob had stated, and in a district where spars could be got he was sure it would be a great saving to the borough. At the same time he considered that the machine was open to the objection he had stated, that it did not break the stones as uniformly as desirable.

Mr. Ashmead (Bristol) said he had had one of those stone-breaking machines in use for many years, but his experience of it showed that the breaking of the stone was not uniform, and the stone was so much crushed that it did not stand any test of wear afterwards. So much had that been the case with the local lime-stone, that he had abandoned the machine altogether.

The President said the question of machine stone-breaking *versus* hand labour was simply one of cost. In some places it was no doubt more economical to use the machine, and in other places hand labour was the more economical, according to the character of the stone.

Mr. Standring (Garston) said as he understood Mr. Jacob about one-fifth of the stones broken by his machine were not fit for macadam, and in places where stone cost 8*s*. or 9*s*. a ton, the loss of one-fifth was a serious matter. As far as his experience went, the machine-broken stones did not wear like those broken by hand.

Mr. Harpur (Merthyr Tydfil) said his board had been negotiating for the purchase of one of those machines just at the commencement of the strike in South Wales, but owing to the strike so many men had to be employed in breaking stones that the negotiation broke through. He believed that if the stone could be broken

at 2*s.* per cubic yard by hand labour, it would be preferable to breaking it by machinery.

Mr. Jacob, in reply, said he believed the manufacturer had some means of preventing such accidents as that referred to by Mr. Lemon by means of a screen. As to the shapes in which the stone was broken, the stone broken by machinery would not be permanent under heavy traffic, but there were a great many country roads on which it would be very desirable.

Votes of thanks were passed to Mr. Jacob and to Mr. Royle for their papers.

BURSTING OF WATER-SUPPLY PIPES IN WINTER.

By Mr. W. H. BAILEY, Salford.

Every winter in this country there are many fatal accidents caused by the explosion of what are known as circulating or bath boilers; there is also a great amount of damage done to house property, and some domestic misery created by the bursting of water pipes, caused by the water freezing in them.

I have paid a little attention to these two subjects, which are somewhat of a kindred nature, and when I was honoured by a request from your Society to read a short paper on them, I gladly acceded to it, knowing the wide-spread influence of your Members, and feeling that some good would be done to society if I could only lay before you certain facts as they appear to me. I feel very diffident of my ability to do this, and hope you will bear with me if I appear tedious in describing things which may be familiar to many of you, but without doing which I might render myself obscure to those unacquainted with them.

There seems to be among many people an impression that domestic boilers often explode through a deficient water supply. I believe that is not the case, and I think it will be very difficult indeed to demonstrate that any accidents have occurred through this cause. A great number of boilers burst every year which are unreported, because not attended with fatal results. Of those which have been reported during the past six or seven years, half appear to have exploded through stoppage of the circulating pipes by ice, and the remaining half have been caused by the fixing of stop-taps in those pipes.

Unfortunately, the great majority of boilers are of cast iron, of the very worst form for resisting pressure. There are two slightly different modes of fixing these in this district, which I will endeavour to describe.

The ordinary and cheap way of fixing and supplying kitchen

boilers is illustrated by Fig. 1. The supply of cold water is received in a cistern at the top of the house, and conducted by the "down pipe" into the boiler; having passed through this, and having become hot, and therefore of less specific gravity, it ascends

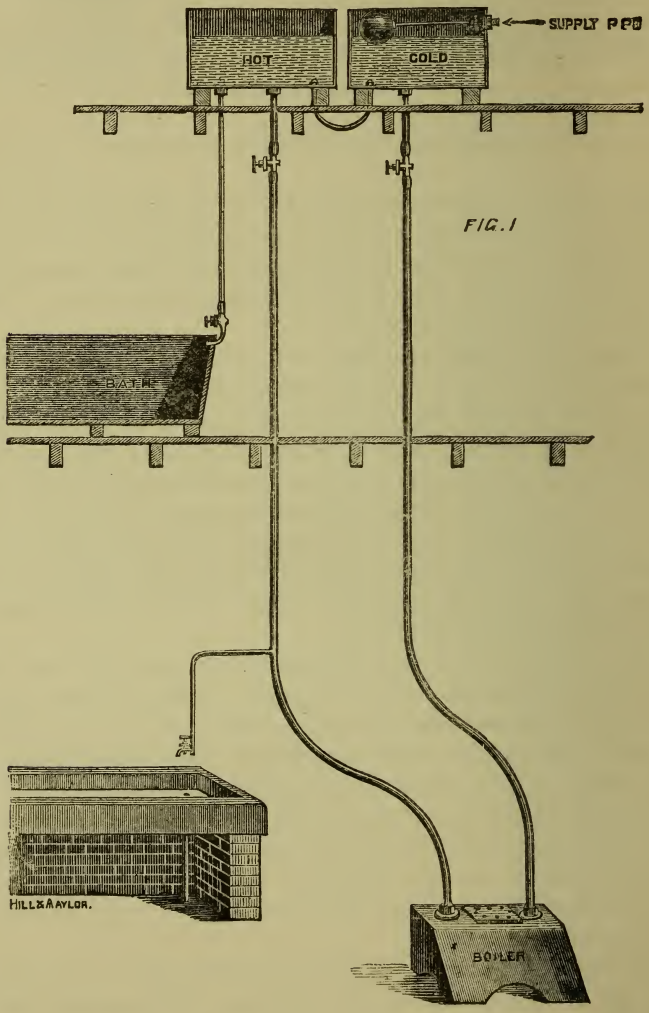


FIG. 1

what is called the "up pipe" to the hot-water cistern, from which it is drawn as required for use.

It will be seen that the pressure the boiler has to sustain when

filled with water depends upon the height of the supply cistern above it; 2 feet 3 inches of water in column being equal to a pressure of 1 lb. on the square inch, therefore 60 feet high will give a pressure of 27 lb. per square inch on the boiler. As, however, most boilers are only about 30 feet or 40 feet below the cistern, we may consider that the average pressure at which they work will be about 15 lb. on the square inch.

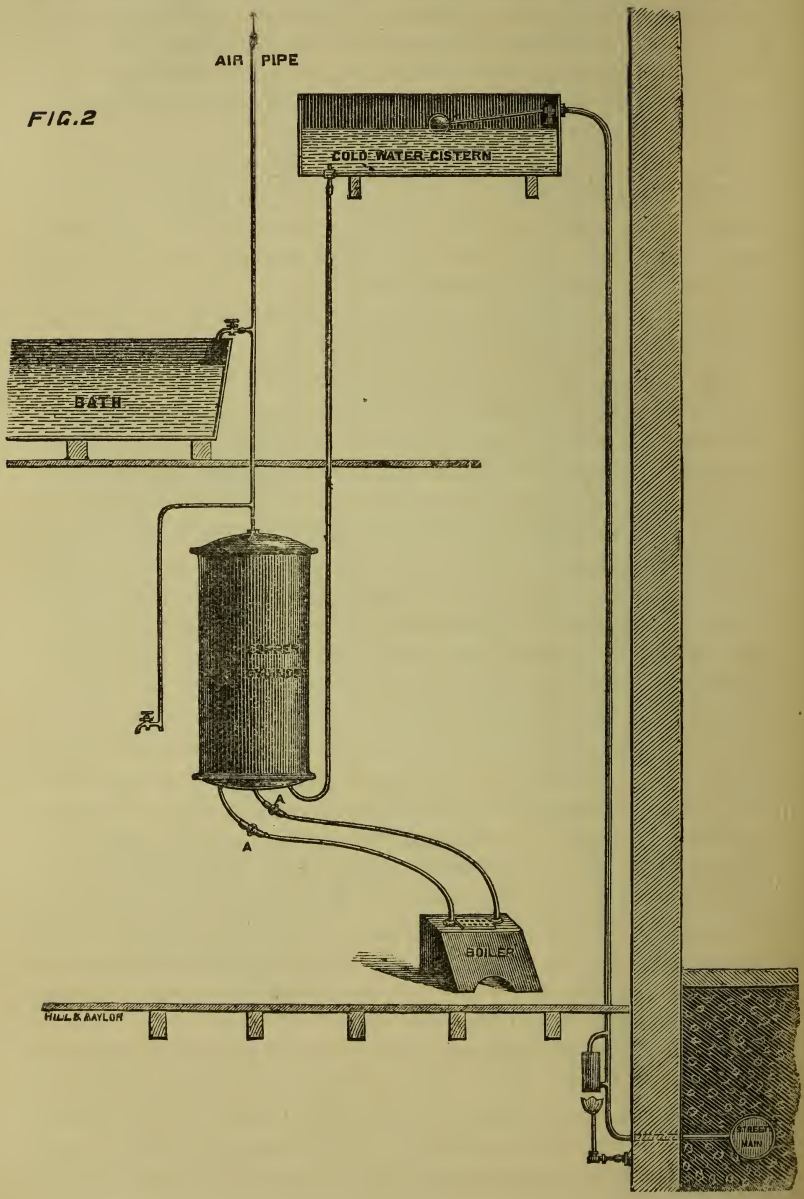
In good houses in this district (Manchester) copper cylinders are fixed in connection with the boiler, in order to give an abundant supply of hot water, and for preventing and rendering explosions impossible; that is, if we are to believe what is told us by more than one respectable tradesman of this district. So much has been said about copper cylinders preventing explosions by men whose business it is to know better, that I will refer to it a little later on.

Fig. 2 represents the arrangement when the hot-water cylinder is used. It differs slightly from the plan I have already described, the hot-water cistern being dispensed with, and a large cylinder, generally of copper, being placed in the up pipe instead. A pipe is taken from the top of this cylinder, called the air pipe, which is open to the atmosphere, and in which water ascends to the level of the cold water supply cistern. The great advantage in using these cylinders is obvious, as the constant circulation which is always taking place causes the water when cool to descend into the boiler, and, when hot, up again into the cylinder, absorbing all the heat possible for the boiler to give it, which is not the case in the simpler and less expensive mode of fixing. Sometimes the hot water is drawn from the top of the cylinder, and sometimes from the air pipe. In both these systems of fixing it will be seen that the boilers are always full of water, and that, supposing the supply of water to cease, it would not be possible to drain them dry, causing the fire to make them red hot, and thus create danger. The source of danger and death is to be found in the direction to which I have alluded; and if there is one thing at all that creates astonishment in my mind, it is the fact that I stand here in this city of Manchester and state that it is unsafe to work a boiler under pressure which has not a safety-valve fitted to it.

With the best intentions many boilers have taps fitted in the up and down pipes, as shown on the model and drawing Fig. 1, so that if any accident occurs to the boiler it may be repaired or removed without fear of inundation. These taps have caused many fatal accidents in summer as well as in winter. If these taps are

by any means closed when the boiler is at work, the water is sealed in the boiler, and nothing can prevent pressure accumulating unless

FIG. 2



the fire be put out. Only a few days ago I talked the matter over with an architect of no mean reputation in this district, who informed me that he would not think of permitting a good house to be fitted with a boiler which had not these taps fixed. He had ordered several houses to be fitted with taps under the copper cylinders, as represented on Fig. 2, A A. I am glad to say he altered his opinion when I explained to him the facility which he thus gave to ignorant or careless people for creating a magazine of destruction. A destructive explosion was created in the house of Mr. Pease, of Darlington, by their means some short time since; and on the 9th October last, at a newly-erected West End club in London, a serious explosion was caused by them. To quote Mr. Lavington E. Fletcher, chief engineer of the Manchester Steam Users' Association, who has kindly rendered me valuable assistance in giving me some facts in connection with these subjects, the boiler was of the ordinary circulating class, connected to a cistern by two circulating pipes. Between the boiler and overhead cistern were two stop-taps; the hand hole in the boiler had been leaking, and a mechanic having been sent for to make matters right, on examining the boiler he shut off the taps. He then left the job, taking the precaution, however, to write over the fireplace—"This fire must not be lighted." Unfortunately, this warning was neglected. The fire was lighted at ten o'clock on the following morning; and as the outlets were both closed, the boiler burst about two hours afterwards, when the front was blown out, and the whole range shot forward into the kitchen. Fortunately, only one man was slightly injured, there being no one else in the kitchen at the time.

The fixing of these stop-taps caused the death of a young woman in January of this year. This is known as the Eccles New Road accident. As it occurred in my own neighbourhood, and in Seedley Ward, which I have the honour to represent in the Town Council of Salford, I took more than an ordinary interest in it. I was the foreman of the jury convened to inquire into the cause of death. It appeared that the proprietor of the house, actuated by a proper desire to make his house safe from inundation, consulted a plumber, who informed him that the best way was to fix two taps, one in the up pipe and one in the down pipe of the bath boiler. These were placed in the bath room, immediately under the cisterns, the boiler not having a copper cylinder. They were fixed where any mischievous lad could have turned them at any time. A leakage during the thaw of entirely different pipes caused the proprietor to

turn these taps off, and having done this he ordered the fire out. A plumber was sent for, and told to make all right; the leaking pipe was soldered, he reported all correct, but omitted to turn the taps on again. The result was that an explosion took place which removed the ranges of the house and the one next door, making a

FIG. 3

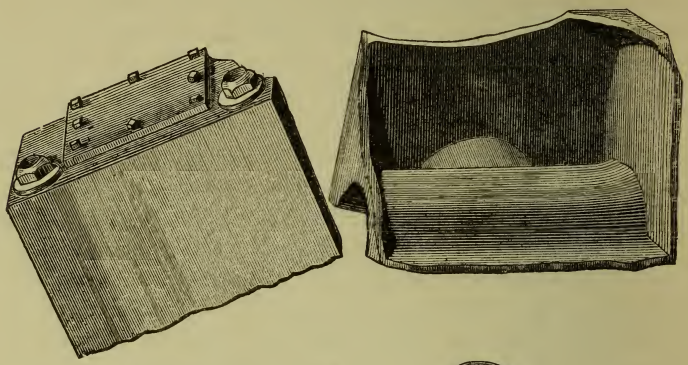
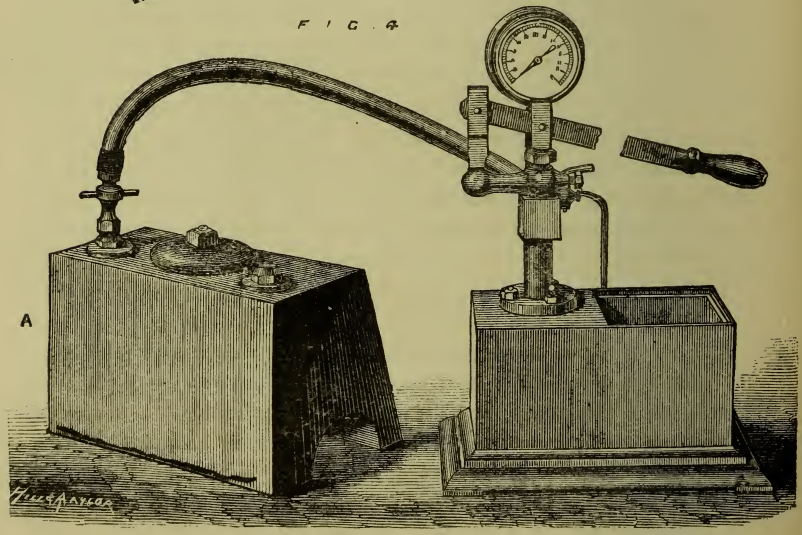


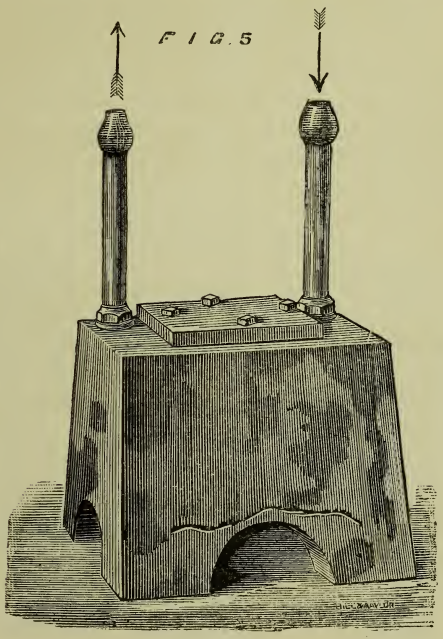
FIG. 4



breach in the division wall sufficiently large for anyone to walk through. The window was blown out, and the poor woman was blown half-way through it. No one was in the kitchen of the other house, or the consequences might have been more serious. The boiler (Fig. 3) which is on the table measures 12½ inches long,

10 inches broad, and is $10\frac{1}{2}$ inches high. The top and front were blown out in one piece; the area of this gives 240 inches, which, if multiplied with the 250 lb. pressure required to burst a similar boiler, gives a total pressure of more than 25 tons. The new boiler (Fig. 4) on the table has been burst by me, by means of hydraulic pressure, by the little test pump attached to it.

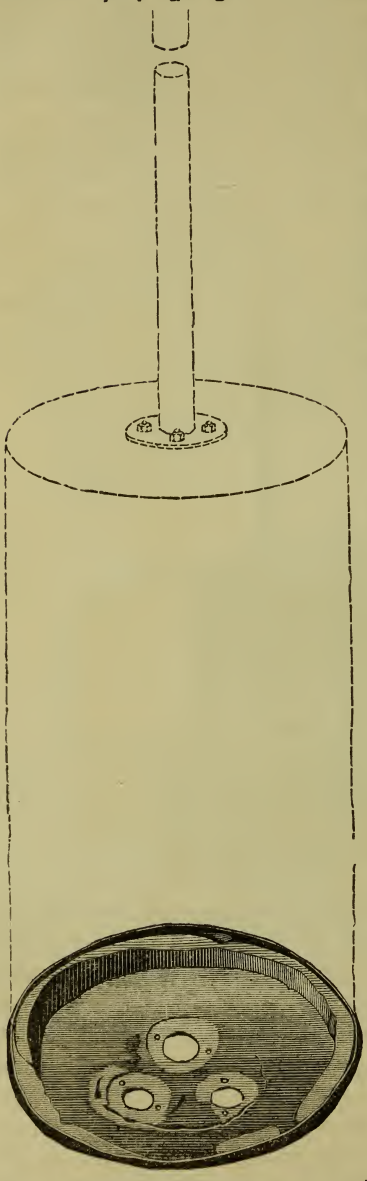
I could give more details of similar accidents caused by these taps, but I think it scarcely requisite to occupy your time with them, having, I hope, proved how dangerous the practice is.



I will now proceed to those accidents caused through the stoppage of the circulation by the freezing of the water in the up and down pipes. These accidents appear to occur chiefly when houses are entered upon by the tenants in the winter time, everything being cold, the water in the pipes being frozen. A fire is put under the boiler by the new tenant, and an explosion takes place. In very severe weather pipes have been known to accumulate ice in one night, those boilers fixed without copper cylinders being most dangerous. Not far from the scene of the Eccles New Road accident, about two years ago, a Mrs. Cowie was killed by an

explosion from this cause. The water in the boiler had longer time than usual to cool on the Saturday night, and Mrs. Cowie having got up late on the Sunday morning, after the fire had been lighted a short time, the boiler burst, and she was blown across the kitchen and down the cellar steps and killed. Another accident from a similar cause occurred near Brunswick Street, Manchester, in January this year, which nearly killed a young woman, and I believe now she lies on a sick bed through the effects. At the same date the copper cylinder bottom (Fig. 6) which is on the table was blown out in a house in Pendleton; there was no one in the kitchen at the time, or they might have been scalded to death. There was another accident to a copper cylinder at Gilda Brook, near Eccles; and in the same week the boiler that was fixed to replace the one that killed Mrs. Cowie, burst with an accumulation of ice, the house being empty. One occurred at Glasgow on the 25th of December, which seriously injured a man; one at Burnley; one at Chorley, which killed a little girl, on the 23rd of December. In this case the tenant had only just entered, and a fire having been put under the boiler, it burst, with the sad result I have named. On December 28th an explosion of a circulating boiler took place at Fulwood Workhouse, near Preston,

FIG 6



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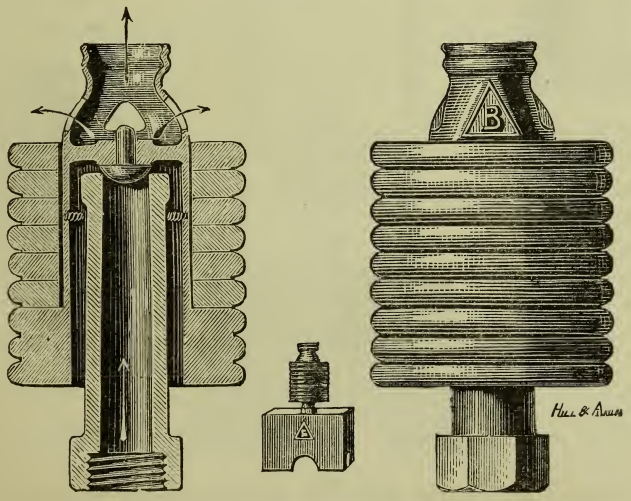
which killed one man and injured two others. December 30th one at Bradford, one at Delph December 8th, one at Ashton-on-Mersey on the 7th December, one at Bolton on the same day, and one at Hyde about the same time. There are a great many of these accidents unreported, because unattended with death. I have found that in the neighbourhood of Seedley, where the woman was killed in January, that no less than five bursts took place about the same time.

Having endeavoured to show the two chief causes of these explosions, the natural question is what is the remedy? what will prevent this destruction of life and property? I have no hesitation in saying that if safety valves had been fixed that every one of the accidents would have been prevented. And as the ordinary lever safety valve would possibly become inoperative in course of time, a little pendulous safety valve of the Cowburn type (Fig. 7) has been

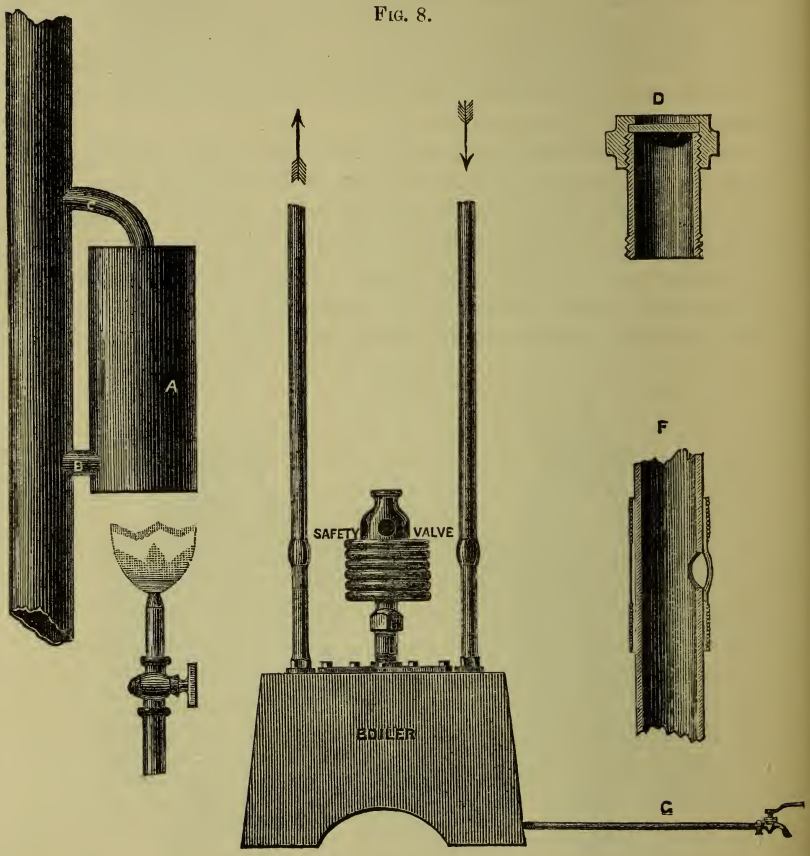
Fig. 7.



recommended, as not likely to get out of order, by Mr. Fletcher, of the Steam Users' Association. If safety valves were fixed on the boiler, I think there is no great objection to the use of taps in the circulating pipes, as they are undoubtedly useful in case of accident. Weak plates of white metal (Fig. 8, D) have been recommended instead of safety valves, which would burst at a low pressure. I have made extensive experiments on these plates, and have burst a great number by actual steam pressure; but I found that I never

could get two alike out of the same mixture of metal. There are also many other objections to them which I will not occupy your time with.

Fig. 8.



A word about copper cylinders for preventing explosions. Circulars have been issued by ironmongers in which it is distinctly stated that these things render an explosion impossible. This delusion, which has such a firm hold in the minds of many people, demands some attention. A copper cylinder fixed to a boiler makes it safer from those explosions which are caused by ice in the pipes. It is just possible that the death of Mrs. Cowie, which was caused by the water freezing in one night, would have been prevented by one, as the hot water in the cylinder makes it a

storage of heat, which resists the attacks of cold for a longer time than a small pipeful will do when fixed as Fig. 1. A copper cylinder only delays the danger a few hours at most in severe winters, and its utility ends at that for preventing explosions. The bottom of the cylinder on the table was blown out through one night's frost; and anyone having a cylinder who wishes to have an explosion in winter can have a hot bath late at night when the servants have gone to bed, he then can empty all the hot water out, which will be replaced with cold, and by this simple means reduce the power of its resistance to the effects of cold and thus cause great danger. A cotton broker of Liverpool bought a small house at Southport, and went into it in the winter time. He was a widower, and required only one servant. He hired one at Southport. After putting her in his new house he went to his business in Liverpool. On his return he found part of the boiler in his little back garden, and part of the gable end of the house blown out. He informed me that the girl was not injured, being in another part of the house at the time. A copper cylinder would not have prevented this accident; a safety valve, at a cost of 8*s.* or 10*s.*, would have done so.

I think that owners of house property would do well to have stop-taps fixed in the bottoms of bath boilers (Fig. 8, G), to enable the water to run out when the houses are not tenanted. I have been informed of several that have been cracked by the accumulation of ice inside the boiler this last winter in empty houses. The one (Fig. 5) on the table is one taken out of a house in West High Street, Pendleton; three others were cracked in the same street. When tenants leave in the winter time it is therefore desirable to empty the water out to prevent this loss.

I hope I have made the subject as plain and as simple as it really is; I hope I have shown to you that this destruction of human life and property is not surrounded or obscured by things which are difficult to understand; that it does not require profound scientific skill to prevent it; that we have it in our power to stop a great amount of mischief without evoking the aid of anything but the most ordinary means.

I am not here as the advocate of any new system of patented mysterious pipes, but simply to say that a safety valve in every case mentioned would have prevented accidents. If this be true, what is the duty of the municipal authorities? It seems to me to be very clear and straight before them.

Action of some sort is imperatively needed, either by the imperial or municipal authorities, in order that these things may be fixed in a safe and proper manner.

Closely allied to the subject we have been considering is the bursting of water-supply pipes in frosty weather through the expansion of ice.

My paper has already exceeded the time allotted, and I will shortly endeavour to describe a little plan which is not patented, and which I think may be used with some benefit. The social misery, without mentioning the damage to property, which takes place every winter from this cause is great, and needs no comment. Various remedies have been suggested, but I have not been able to find that any have been successful. Elastic diaphragms, rubber balls (Fig. 8, F), and many ways of creating more space in the pipes to allow the ice to expand, have been suggested, but without effect. Strong pipes will burst when water becomes ice. Hydraulic cylinders that will bear a pressure of five tons on the square inch have been cracked in Manchester warehouses by the water freezing in them. If this be so, it will be apparent that stronger pipes than those at present used will not prevent the evil; therefore if we cannot get pipes of a material that will bear the pressure of ice, the next best thing is to prevent the ice accumulating.

This may, in some cases, be done by covering the pipes with felt and fixing them on inside walls. As, however, most water-supply pipes are fixed on the inside of outer walls, and therefore very easy to become frozen up, it has occurred to me that if a little cylinder and gas jet be used, as illustrated at Fig. 8, A, it might keep the water warmer than freezing point, at a very small expenditure for gas. The cylinder may be about 6 inches long and 3 inches in diameter, and might be fixed in the cellar at a point where the water enters the house, being connected by a small tube B and C, at each end to the water-supply pipe of the house. Under this cylinder, during frosty weather, a very small jet of gas might be constantly kept burning, which would cause the water to ascend, and thus promote a slow circulation. If, however, a separate pipe, quarter-inch bore, were to be connected to the top of the cylinder, and then taken and connected to the highest and coldest part of the water main, it would be made more effective, as the circulation of warm water would be then complete.

The PRESIDENT said Mr. Bailey's paper contained many valuable facts, and if anything could be done to prevent those accidents it would be exceedingly desirable.

Mr. LEMON (Vice-President) asked if, instead of having an ordinary tap which any servant could turn, a square head-tap was used, would not the objections referred to be to some extent removed?

Mr. BAILEY replied that unfortunately most of the accidents, as far as he had any information, had originated with the workmen.

A vote of thanks was passed to Mr. Bailey for his paper.

ON THE INCREASED DEATH-RATE IN TOWNS AND SOME OF ITS CAUSES.

By E. B. ELLICE-CLARK, Assoc. Inst. C.E., Town Surveyor, Ramsgate.

At a recent conference on sanitary matters Dr. B. Forster read a paper on the comparative mortality of large towns, and compiled a table of mortality for eight districts. This most valuable document was added to the proceedings of this Association, and to my mind is a startling one. By a reference to it it will be seen that out of seven of our large towns, from 1850 to 1870 the death-rate from all causes has increased in every town but one, Bristol, where it remains the same. Now when we come to consider that in each of these towns, except Manchester, there has been introduced a system of water-carriage drainage, it is but natural that the general public should draw the inference that the Sanitary Engineer, so far as he has gone, has failed in his mission. By a reference to the returns of the Registrar-General, I find Dr. Forster's figures confirmed; and going back another decade, we find that the death-rate of London between 1841 and 1851 was 24·4, being the same as it was between 1861 and 1871. So that the sanitary precautions adopted in the metropolis, so far as life-saving is concerned, have been a failure. Nor is this the case in London only; in Liverpool the death-rate has gone from 36 to 39, in Leeds from 27 to 29, in Birmingham from 26 to 27; and upon a further examination of the Registrar-General's returns, it will be found that in nearly all our large towns the death-rate from 1841 to 1870 has increased. In the eleven divisions of England, as the death-rate has remained stationary at 22, we have forced on us that, notwithstanding the millions of money we have expended on drainage and water supply, we have throughout the country been unable to reduce it.

The opponents of drainage have not been slow to notice these facts, and point to these ominous figures as an indication that it would have been better if towns had neglected to adopt the water-carriage system; but I cannot agree with them. To those who carefully watch public opinion, it will have been apparent for some

time that there has been rapidly growing up a strong prejudice against water carriage, especially in the north of England; but to my mind water carriage has but in few instances had a fair chance. I fear at the commencement of the sanitary crusade, for the purpose of gaining public pressure, far too much was promised; that those who commenced sanitary work had no idea of the Augean stable they were attempting to clean. A modern writer,* speaking of what sanitarians call preventible diseases, says: "Instead of holding out fallacious hopes that never will be, never can be, realized, and instead of attempting to throw the blame on others, it would seem to be better, sounder policy, frankly to avow the fact that these general pestilences are due to the operation of natural causes, and that they are regulated by natural laws over which man has no control." When we have a public statement of this kind, and an increased death-rate in our towns, I think it is time for us to inquire into the causes, and ask how it is that sanitary works have generally failed to effect a diminution in the rate of mortality. I attribute this, not to the water-carriage system, but to the details in connection with its application, and other causes.

1. To the *indoors* water-closet;
2. Imperfect sewers, including want of ventilation;
3. The modern dust-bin;
4. The general want of sanitary knowledge, both of officials and the public;
5. The house connections.

The modern indoor water-closet has taken the place of the old-fashioned garden privy, which, as a rule, was built as far from the house as possible. Now, no house is considered perfect without a number of water-closets, many of them adjoining and forming part of the bedroom in the larger houses; while, in the smaller class of dwellings, it appears usual to think of everything else but this necessity; consequently we find it under stairs, between walls and chimney jambs, under street pavements; in fact, everywhere except where it should be, all placing reliance on the false security of water traps.

By the returns submitted to you last year, we found that there were only a dozen towns sewered where anything like adequate provision was made for the ventilation of the sewers. In most of the towns where drainage was executed prior to 1870, no syphon pipes to the main connections were used; consequently the small

* J. Parkin, M.D.

quantity of water in that modern abomination, the lead D-trap, was soon charged with gas, and the higher temperature of the house soon made the down-pipe a distributor of sewer gas into the houses; too often right under the noses of the sleepers. The old cesspool, with all its faults, was better than this modern indoors closet. When placed some distance from the house, the gases generated were constantly diluted, being always in the open, and were thus rendered comparatively harmless.

Now we have advanced so far in sanitary science as to construct a funnel directly from a sewer, too often charged at high pressure with most poisonous vapours, into our very bedrooms. The consequence is that the whole system of sewering is at once condemned as being wrong and dangerous. The remedy of this evil is—do away entirely with the indoor water-closet. It is, however, necessary for old and weak people that a water-closet should be in close contiguity to the house. This may be effected by building the closet two feet from the house, and having an open iron-grating floor as the only communication between the premises. Through an opening of this sort there will be at all times a current of air by which the gases will be carried off. In all modern houses having indoor water-closets, I would strongly advise their immediate disuse; where, however, this cannot be effected, let there be an aperture such as I have described, and not less than one foot, cut between the house and the closet, for the admission of external air, so arranged that it cannot be stopped at the will of the user. Of the closets in the centre of houses without external ventilation, not one should be allowed to remain, for I lay it down as a law that no house so situated can be healthy, and I consider it an imperative duty of the Legislature to stay their use.

Of the many miles of imperfect sewers in England, in the presence of the representatives of those places, it befits me to speak with caution; but I fear that in a large number of towns, especially the smaller ones, the sewers are far from perfect. An eminent Engineer told me that a main sewer in his town fell 4 feet the wrong way; a few months ago; a paragraph in the *Builder* informed us that in a 12-inch main sewer in a south of England watering place there were 9 inches of deposit. Mr. Stevenson, of Cambridge, has recently reported to his Board that many of the main sewers in that town are choked; in some of the London districts it is a well-known fact that the old sewers are constantly silting up. I myself have taken up numerous portions of sewers

with inclinations the wrong way. Mr. Deacon, of Liverpool, in 1873, drew up a long report on the defective construction of the sewers of that town, but says they were rapidly improving them; and I fear many towns have most defective sewers, but are not following the example of Liverpool in putting them in order. This is a large matter, and one that cannot be altered without much expense. The officers having charge of sewers should not fail to make themselves acquainted, by personal inspection, with the state of such sewers, and report on them at once. These alterations may be made gradually, without too much burdening the ratepayers. For the defective sewers constructed in towns since 1848, I blame the Governments. It was clearly their duty to see that the money borrowed by towns for the construction of these works was properly laid out; and properly qualified Engineering inspectors, appointed by the local bodies, but approved of by the Local Government Board, ought to have been selected; this should be made compulsory. In many towns neither Surveyor nor Engineer has been appointed to carry out these works; the consequence is, that the sewers are, and will remain, sewers of deposit—to bring odium on the water-carriage system.

The third cause of disease, the dust-bin, is another abomination that should be swept away. Under the old system it was the custom to throw everything into the garden privy, now it is the fashion to have a bin filled with decaying vegetation, at a distance termed "handy for the servants"—in towns, frequently in areas, back kitchens, often in the kitchen itself. Many medical men and Sanitary Engineers have loudly declaimed against this nuisance. We all know what a difficult question it is with our Boards. In London it is the most trying that local boards have to deal with. The contents of dust-bins are frequently left for weeks together without removal. From the returns of the Committee of the British Association in 1873, it was found that a majority of towns made no provision whatever to take away the house refuse, throwing the onus of removal on the occupier. The consequences are well known to us—that it is removed only when the stink is so bad that the occupier can stand it no longer. A deposit for dust became necessary when the privy was done away with. Experience has taught us that the dust-bin is as dangerous, and frequently more so, than the privy itself. I would urge upon every Surveyor the absolute necessity of inquiry into this evil, for he will find I have not overstated it, and if he can get his Board to do its duty,

he will sweep away all dust-bins, and replace them by pails to be emptied each morning, a practice which, in some cities, has been found to be even less expensive than the bin system which is productive of a large amount of preventable disease.

The fourth cause, the general want of sanitary knowledge, is unfortunately not only the case with the public at large, but with a number of those who are entrusted with the carrying out of the Sanitary Acts. We had last year a painful exposition of this from our Secretary, who pointed out this evil with great clearness. The appointment of these officials, who have had no previous training whatever, must bring discredit on us all, for if those in power are not cognizant of the cardinal points of sanitary science, how can we expect the people at large to improve under their tuition, for I take it that all sanitary officers are teachers of public health.

The want of knowledge on the commonest laws of healthy homes that is apparent is deplorable; and this is the more important, for we must not forget that the modern Sanitary Engineer has substituted a complicated system for the removal of excreta in the place of a primitive one; and that the success of modern sanitation largely depends on the individual. Those who have had practical experience of water-closets in poor neighbourhoods will bear me out when I say that it would have been difficult to devise a more complicated or unsuitable receptacle for the poor than the modern water-closet, for they are a constant and fertile source of epidemic disease in close, pent-up neighbourhoods, for want of a little knowledge on the part of the users. The question is a difficult one with the very poor; but I venture to hope that one of the first things the new School Boards will have taught, will be the grand principle of cleanliness; a few simple lessons could readily be drawn up, and should be committed to memory as hymns are in national schools, at an early age, for I am convinced without the aid of the people themselves all the sanitary precautions in existence will be utterly useless; if we can but instil into the mind of the working man that his health is his capital, and that it can only be retained by performing a few plain duties, we shall have accomplished much to help the sanitary authorities.

The fifth cause of a high death-rate is that of the private connections with the sewers. I know nothing that has contributed

so much to preventable disease in sewered towns—in very many places where the main sewers have been excellently constructed by eminent engineers, these connections have been left to be made as the local authority might think fit; in some towns I am acquainted with, the main sewers have been laid for twenty years, and only ten per cent. of the houses are now connected, and yet they are included in the generic term of sewered towns; in a majority of towns these connections are left to the private owners, many of whom think more of their cost than their efficiency, so that the drains are ill-laid with bad materials. In London it is a notorious fact, especially in the larger houses, that the drains are in a dreadful condition when examined by competent persons. In my own town, previous to 1872, the private connections were generally executed by bricklayers without any professional supervision whatever, and, as a shilling was an object to many of the men employed, too frequently the drains were without any traps, and left with gaping joints under the floor boards. I consider the culminating point of drainage to be the house drains. If these are not most carefully planned and carried out, the most perfect system of main sewerage in the world must break down. I am strongly of opinion that all works of drainage, whether indoors or out, should be executed by the sanitary authority, and charged for before the works commence, as under the Metropolis Local Management Act it is the only efficient way of executing them, without which, cunning builders will be sure to defeat the object of the sanitarian.

In conclusion, I would urge all our public boards to use their influence to do away with the indoors water-closet;

To have a thorough examination of their sewers, and ventilate them;

To eradicate the dust-bin, and substitute the daily-pail system;

To call the attention of the School Boards to the question of teaching the elements of public and private sanitation;

To endeavour to ascertain that their officials are competent men, and if not, to obtain them at once;

To obtain legislative powers, so that all works of drainage, indoors and out, be constructed by the sanitary authorities.

Should this be accomplished, we shall have progressed so far as to remove some of the causes of a high and increasing rate of mortality in large towns.

TABLE SHOWING DEATH-RATE FOR THREE DECADES, OF TOWNS OF 40,000 POPULATION AND UPWARDS.

Town.	Population.	Death-rate.			Drained or not.
		1841–50.	1851–60.	1861–70.	
Bath	52,548	24	22	22	Yes.
Birkenhead	45,418	20	19	23	,,
Blackburn	78,000	19	21	20	,,
Birmingham	..	26	27	27	,,
Bolton	90,000	27	27	26	,,
Brighton	92,473	21	22	22	,,
Bristol	182,524	92	29	29	,,
Burnley	40,900	23	24	24	
Bury	45,000	25	23	24	,,
Cheltenham	41,923	20	19	19	,,
Croydon	56,000	20	19	19	,,
Dudley	43,790	25	26	25	
Gateshead	48,592	25	26	25	
Great Yarmouth	41,105	23	25	24	,,
Halifax	65,800	22	24	24	,,
Huddersfield	70,250	22	22	24	,,
Ipswich	42,839	23	22	22	,,
Hull	128,125	31	25	26	,,
Leeds	272,619	30	28	30	,,
Leicester	95,083	..	25	26	,,
Liverpool	493,346	36	33	39	,,
Manchester	355,665	33	31	32	No.
Middlesborough	50,000	16	20	22	
Newcastle-upon-Tyne ..	133,678	27	27	28	Yes.
Northampton	42,000	24	24	24	,,
Norwich	81,000	24	25	24	,,
Nottingham	90,000	26	27	24	,,
Oldham	82,619	26	25	26	
Plymouth	68,758	25	24	23	,,
Portsmouth	120,000	25	23	21	,,
Preston	85,426	25	27	28	,,
St. Helens	45,000				
Salford	124,825	28	26	27	
Sheffield	239,947	27	28	29	,,
Southampton	53,741	23	24	23	,,
South Shields	45,336	26	24	24	
Stoke	..	27	26	26	,,
Tynemouth	40,640	24	23	24	
Walsall	50,000	24	26	24	
West Ham	62,919	18	20	20	,,
Wigan	40,000	28	27	29	
Wolverhampton	70,000	27	28	24	
Average	..	24·8	25·3	25·5	

ARTIZANS' AND LABOURERS' DWELLINGS.

By R. VAWSER, M. Inst. C.E., Borough Engineer, Warrington.

Our rules provide that papers submitted for consideration shall have a practical bearing, and be written rather to explain results actually attained, than to air the opinions of the writer; but as the subject I propose to discuss is of primary importance, I venture to lay before you some reflections, not altogether because they are based on successful experiment, but because, so far as can be seen, they present the only possible solution of a great social difficulty.

The attention of local authorities is now largely directed towards improvements involving immense clearances of property, and few will question the wisdom of this policy; but one cannot fail to observe that where crowded rookeries and back slums are suddenly improved out of existence, a most vicious system of overcrowding has been initiated, which requires a powerful and intelligent remedy.

As a partial preventive to the continued destruction of houses, Parliament now insists that railway companies closing houses for their own benefit, shall erect a corresponding number of houses elsewhere. I would suggest that this regulation should be extended to all trading communities, and to the destruction of property for municipal and every other improvement.

Some provision of this kind is necessary even in favour of the skilled artizan, who as a general rule is well able to take care of himself; but those whom misfortune has made poorer than the rest urgently require a helping hand, to preserve their identity with humanity. The evil results of overcrowding are not confined to those who are unfortunate enough to be poor, but are shared by all alike, and all have a direct and personal interest in preventing it, our chances of prolonged life increasing exactly in proportion with the success of our efforts to improve the condition of our poorer neighbours.

I venture to hazard the opinion that they who live in filthy courts and cellars would not be found there if better accommoda-

tion were provided at a price within their means; and I submit that the local authority which permits overcrowding when it has the power to prevent it, fails in one of its first duties to its constituents. Something is being done by individual efforts, but private enterprise is insufficient at the present crisis, and the *authority* ought to be required to do something. The character of a man very much depends on the associations of every day life; and the influence that most promotes a feeling of reverence for home does most to emancipate a man from the attractive degradation of the liquor vault.

The Artizans' Dwellings Act, 1868, gives the authority power to put into habitable condition, at the expense of the owner, tenements not fit for habitation; it also provides for extending the repayment of costs over a series of years, and making the outlay a first charge on the property, thus removing a difficulty often felt by those who have only a limited ownership, and who are otherwise desirous to do what is right. The Labouring Classes' Lodging Houses Act empowers the authority to erect labourers' houses, and for this purpose to borrow money on the security of the rates, and to appropriate for the purposes of the Act any land over which the authority has control; neither of these useful Acts has been very extensively adopted. The officer of health is directed to put the machinery of the Artizans' Dwellings Act in motion, and it afterwards becomes the duty of the surveyor to advise on matters of construction. I am sure no surveyor can fairly be charged with making the Act inoperative.

I have long entertained the idea that when private enterprise fails to provide sufficient houses for the working classes, it becomes the duty of a sanitary authority to do so. Gaols are provided for criminals and workhouses for the helpless, but the class from whom these institutions are recruited are uncared for and ignored until they become too helpless to be anything but a burden to society, or too depraved to earn an honest living. I venture to assert it is as much the duty of society to contribute towards keeping the poor in a state of honest independence, by providing healthy homes for a reasonable rent, as by erecting workhouses and gaols; and as much a duty to aid them while living as to provide cemeteries for them afterwards.

Under ordinary circumstances it would not be difficult for private enterprise to keep pace with the demand for labourers' dwellings, but the immediate and pressing want is a substitute for those

already removed to make way for modern improvements; and these, I submit, sanitary authorities should provide. This will entail no burden on the rates; for it is clear, as money can be borrowed at low rates of interest, the rents will suffice to pay the interest, and in a few years to redeem the borrowed capital. In some few places houses have been built under the provisions of the Labouring Classes' Lodging Houses Act with satisfactory results. It was announced at the Birmingham Conference, that although exceptionally heavy expense had been incurred in establishing the system in Liverpool, the interest paid as rent amounts to nearly 5 per cent. on the original cost.

The Acts of Parliament regulating the erection of new houses give but little hope of improvement in the immediate future. Attenuated houses run together by jerry builders are now the order of the day; scamped work in every direction, outside walls through which an ordinary wind drives a passing shower; party walls which will not prevent tenants in one house hearing everything that transpires in the next; untrapped drains, communicating direct with the house; double-hung windows that will neither shut nor open, are by no means exceptional peculiarities of modern construction; and until a Building Act is passed making it compulsory to erect houses consistent with the necessities of the age, and the surveyor is armed with powers to enforce it, these anomalies will continue.

The Building bye-laws under the Local Government Acts have been found sadly deficient in practice, as was shown by the paper read at Birmingham by Mr. Lemon, Vice-President, and the discussion which followed; only very little power is given to the surveyor, and his efforts are not unfrequently rendered abortive by the local authority. Outside walls when built of porous materials should always have an air space or cavity in the centre, and a little above the ground a damp-proof course, to prevent moisture rising. If precautions such as these were more generally observed, houses would be more comfortable to live in, more healthy, and not much more costly.

In speaking of the construction of houses, especially cheap houses, I would suggest that cement concrete has hardly had a fair trial; authorities differ as to its advantages, one saying that it is impervious to moisture, others maintaining the contrary; my own experience is favourable to its use, and generally its cost, as compared with bricks, will commend it where gravel can be easily procured.

All well-to-do artizans can now afford to live in houses with three bedrooms, and pay a liberal rent; but there is a class to whom I have already referred, who perhaps do not require quite so much accommodation, and who certainly are not in a position to pay for it. The large sum devoted by Mr. Peabody was evidently intended for this class, but it is rather doubtful if they have reaped any great advantage from it; the Peabody houses appear to be designed on a scale much too large, and with rents proportionately high; so far from the poorer class residing in them, it is said some of the tenants are well able to afford houses elsewhere, and although not entitled to consideration on grounds of poverty, prefer to live there because they get better accommodation at a cheaper rate than is possible under a private landlord. No evidence could be more instructive on this head than that lately contributed by the professional newspapers, from which it appears that the total cost per house of the 954 dwellings erected by the Peabody fund amounted to 313*l.* each; while those erected by the Industrial Dwellings Company cost at the rate of 137*l.* each; the result being that the Peabody fund realizes 2 per cent. on the capital expended, while the investment of the Company yields 5 per cent. When we remember that the very liberal bequest of Mr. Peabody was designed specially to benefit the very poor, we are forcibly convinced that either the trustees of that fund, or their professional advisers, have neglected to act in accordance with the spirit and scope of Mr. Peabody's will, or that the Company contains men far better qualified to appreciate and provide for the wants of the labouring classes.

A paper on this subject would be incomplete without a passing reference to those associations established for assisting working men to become their own landlords, by payment of a small weekly addition to the rent. Where this is done we shall find the occupier takes more pride in his house, and his vacant moments, which might otherwise hang heavily on his hand, are eagerly devoted to the improvement and adornment of his property; he has, moreover, something to fall back upon in case of illness or misfortune.

DISCUSSION.

The PRESIDENT said, Mr. Vawser used one expression in his paper which he thought the Association would ask him to alter. He spoke of "our friend the jerry builder." The jerry builder was certainly no friend of his (the President's).

Mr. VAWSER: It was merely a figure of speech.

The HON. SECRETARY (Mr. C. Jones) said he could not help complimenting Mr. Ellice-Clark on the very careful paper he had brought before them. He said it without any feeling in respect of any other paper, but he regarded it as most practical and interesting. There were, however, one or two points that he objected to. As to Government protection, that was all very well, and it might be wanted; but having Government Commissioners coming down to inspect waterworks, look into the sewers, and so on would be taking a step in the wrong direction. He thoroughly agreed with Mr. Ellice-Clark in regard to the dust-bins. If there was one point to which the attention of Surveyors should be called above all others, it was the dust-bin. He looked upon it as the very focus of three-fourths of the disease that we had. As Mr. Clark had represented, it was put in a most improper place. It was the nearest possible place to which the housemaid or cook might consign all manner of materials, and he believed that the diseases of children more frequently arose from coming in contact with the deleterious gases that sprung from the decomposition of vegetable matter in the dust-bin than from any other cause. He should most thoroughly advocate the pail system in its place, however much he might object to it as far as the previous day's discussion was concerned. He thought if the Association took the question up and brought a little pressure to bear on the authorities, they would do a very great thing in getting rid of the modern dust-bin and substituting for it the pail, to be removed every day or every third day. It would be a great benefit to the country at large.

Mr. ANGELL (Past-President) joined in complimenting Mr. Ellice-Clark on the excellent paper he had read. On most of the points touched upon he agreed with Mr. Ellice-Clark. On one point especially he agreed with him, namely, that the construction of house drains, both inside and out, should not only be under proper supervision, but should be executed by the authorities themselves. The efficiency

of the house drains was the one point on which almost everything in house sanitation turned. The "jerry builders" referred to by Mr. Vawser constructed drains in a most incompetent manner, the work was left to the most incompetent men, and it was impossible without a large staff to superintend such matters properly. He also agreed with Mr. Ellice-Clark with regard to the dust-bin nuisance. They all knew the trouble of getting the dust-bin emptied. Sometimes the contractor was three or four weeks, and sometimes longer, without calling, and during that time the most unhealthy accumulations were going on. As a matter of convenience he did not agree with Mr. Ellice-Clark in placing all closets away from the house. The water-closet close to or in the house was now so much a matter of convenience that the public would not consent to its removal; if the closet was attached to an external wall and well ventilated, anything offensive or dangerous from it would be reduced to a minimum. He wished to refer to one matter in Mr. Vawser's paper, namely, concrete buildings. He had some experience in concrete buildings. There were several so-called concrete cottages in his district. The builder called them concrete, but he (Mr. Angell) called them mud huts. If the material used was really concrete, it would make a very good building; but concrete was used for economy, and in nine cases out of ten the concrete was very badly made, the cement was bad, the mixing or proportions were bad, and he had known several cases in which houses had fallen. Concrete building required great supervision, and no Local Board officer could devote sufficient time to such supervision.

Mr. Monson (Acton) thought Mr. Ellice-Clark launched out rather too decidedly in his opinion sometimes. He (Mr. Monson) learned for the first time that small towns were imperfectly sewered. With regard to the dust-bins, the removal of the stuff from the London dust-bins must be frequent, and if it was otherwise it must be owing to the neglect of the contractor. With regard to the Cambridge sewers, everybody knew that Cambridge was in a flat district, and in such a case sewers were often choked for want of cleaning out. As to sewer ventilation, he did not think that would carry them over all their difficulties. Sewer ventilation had done a great deal, but he thought a great deal of the offensiveness of sewers arose from obstruction. If sewers were kept free there would not be half so much trouble with them.

Mr. Lemon (Vice-President) said he would go in for the entire removal of dust-bins, as he looked on them as a source of disease. A

good dust-bin might, no doubt, be had on various scientific principles. They could have a separate place for the refuse, and screen the ashes, and so on ; but people did not want dust-bins, they wanted something that would shut, something with a lid on. He thought it was most desirable that there should be in every house a box or tub with a cover, so that the house refuse could be easily removed. As regarded the indoor water-closets, he objected to them, but he could not agree with Mr. Ellice-Clark that there was any chance of having them removed. By all means the water-closets should be placed near the external walls, and never in the centre of the building. Another thing desirable was that there should be an open lobby, with a free ventilation or draught, between the water-closet and the house. As to the sewer deposit, every sewer should have a constant flow, and if the sewers had a constant flow there would be no deposit. Another cause of deposit in sewers was letting the rain fall into them. The rain water swept in a lot of matter from the gulleys, which caused a great amount of deposit in the sewers, and that of course prevented the other matter that passed into them from being washed away. In his own borough (Southampton) he separated the rainfall as much as possible from the sewage, and the sewers that used to be said to have a large amount of deposit in them were now perfectly free. He quite agreed with Mr. Ellice-Clark that the connection of the house drains with the main sewers should be under some supervision. In his borough, whenever a connection was to be made between a house drain and a main sewer, they made the builder a present of the junction, and the effect of that was that no builder sought to evade the notice which he was required to give, and the connection was then made under proper supervision. If further inspection of private drains was required—and it was a most important question in connection with the water-carriage system—there should be a larger staff, and the local authorities must put their hands in their pockets. He was much obliged to Mr. Vawser for his interesting paper, and he agreed with him that the present Bill before Parliament was very defective, and not much was to be expected from it. He would go in very strongly for a Building Act for the whole kingdom. There was a great difficulty, on account of vested interests, in getting proper bye-laws passed. In his borough they had some good bye-laws, including everything Mr. Vawser recommended, and if he had a proper staff he could have them carried out strictly, but he had not a proper staff. Another matter he wished to press on those who

carried out the bye-laws in boroughs, was that in his borough the Town Clerk, whenever a question concerning them arose, told the Committee that the bye-laws had been passed by the Secretary of State, and they had no option but to carry them out. The result was that the Committee did not yield to any pressure that might be put on them from outside. That would be a very useful hint for Sir Joseph Heron, who, he regretted to say, was not then present.

Mr. Pritchard (Vice-President) agreed with Mr. Ellice-Clark as far as regarded the removal of water-closets from the interior of houses, which might possibly become a nuisance from the want of proper ventilation of the sewers and branch drains, and he also agreed with the Past President (Mr. Angell) that they should not indiscriminately take out every closet, which, to a certain extent, must be looked upon in those sanitary days as a luxury. The closets should not be removed outside the houses except in such special cases in which it was deemed necessary to do so. With proper ventilation of the main and branch sewers, and other easy precautions, there was not that necessity for the removal of closets from the interior of houses that there would otherwise be. He agreed that the deposit in sewers caused a greater necessity for ventilation. He found by his experience that the deposit was caused by not having a duplicate system of sewers, because if sewers were properly constructed and placed in proper gradients, no deposit from ordinary sewage water would be formed. The question of dust-bins he believed they were unanimous about. He agreed with the other speakers as to the necessity of a proper supervision over the construction of house drains, and that there should be a sufficient staff for such work. All depended in a great measure on the manner in which the drains were laid. For his part he would make it imperative that no sewer or water pipe should be attached except by the man employed by the local authority.

Mr. Harpur (Merthyr Tydfil) said the district with which he was connected had a population of 60,000, and the result of the sanitary measures carried out there was that the death-rate had been reduced from 36 to 26 per thousand. There were no ashpits in the town, excepting public ashpits. There was not an ashpit connected with a workman's cottage in the district of Merthyr Tydfil. The authorities had set their faces against it, and the system was to remove the ashes daily. He thought the suggestion

a good one, that there ought to be instructions given in the public schools as to sanitary matters. The children should, in fact, be taught to use the water-closets. Before sanitary matters were taken up there some years ago, there were whole streets without a single closet of any kind, and even now a great many of the older people preferred going into the fields and to the river side, rather than into a closet. With regard to the connection of the house drains with the sewers, they were a little in advance of other places in Merthyr Tydfil. They allowed no connections to be made except by their own man. Within the last three months the Board had, by the advice of the medical officer of health, closed some forty or fifty cottages as being unfit for human habitation, but no provision had been made for erecting cottages in lieu of them. There certainly ought to have been, and that was a defect that should be supplied by future Acts of Parliament. Whenever cottages were demolished as unfit for human habitation, cottages should be erected in their places. The result of not doing so in Merthyr Tydfil had been over-crowding in other parts of the district. The Artizans' Dwellings Act had been adopted by his Board, but they found so many obstacles in the way of carrying it out, that they had been obliged to abandon proceedings under it. He believed the first proceeding was for the medical officer of health to report that such and such a house was unfit for human habitation. The case was then transferred to the surveyor to examine, and perhaps suggest what should be done for improvement. Then an interval of three months must elapse, notice to be given to the owners, and the owners could come before the Board and make their objections. The result in Merthyr Tydfil had been that nearly all those objections had been acknowledged by the Board, and the proceedings had, in consequence, fallen through. They had been building concrete houses there, and he had found them to answer very well. He could not agree with Mr. Angell that they were mud huts. Quite the contrary, but it was because they had such excellent material.

Mr. Royle (Hulme) said, in his district the junctions between the house drains and the sewers were made under the supervision of the local authorities, and the new buildings erected under the bye-laws were also inspected by the building surveyor.

Mr. Jacob (Barrow-in-Furness) said, in his district deposits in the sewers had been prevented by a duplicate system of sewerage in the low-lying grounds. It was now becoming generally established

that in the seaside towns, where parts of the towns might be below the level of high water, pumping became necessary, and the best mode of managing the sewers was by a duplicate drainage. Though at first sight it might appear more expensive, it was not so, when they came to discuss it, and compared it with the annual cost of pumping. The suggestion made by Mr. Vawser as to cavity walls deserved respect, but something radical would really have to be done before they could induce the Legislature to pay attention to matters apparently of small importance. As to dust-bins, all had not been accomplished in Barrow that was to be desired. They had twenty feet back streets there, and they were enabled to put the dust-bins against the back walls, and they were accessible from the outside, so that the privacy of the tenants was respected.

Mr. Fowler (Salford), referring to the collection of ashes, said in the Manchester district, as they knew, the principle was pretty generally adopted at present, and it was getting to be much adopted in Pendleton. His observation of cinder-sifters was, that the ashes, instead of being thrown into the copper, were very often scattered all over the yard attached to the house. In manufacturing districts, where the adults were employed in the mills, when they got home perhaps their children helped them to clean the house, and it was very often the children who carried out the refuse. The cinder-sifter was often too high for the child to be able to throw the ashes into the copper. He considered the collection of the refuse by means of receptacles with handles a most excellent system. Mr. Harpur had no doubt seen the mode of collection in Cardiff. There they brought small tubs in the morning into the public streets, and when the carts passed along those receptacles were collected and put into them. About eighteen months ago he went down to Cardiff to see some of the dwellings there. The Borough Surveyor showed him through the lowest and poorest districts of the town, and the back yards there were as clean as possible, simply from the fact of the mode of collection of the refuse. With regard to Mr. Vawser's paper, he should have been much more pleased if he had given a description of the three different classes of working men's dwellings. The one class was back to back, similar to what were to be found in Yorkshire. The houses were built in blocks, and the privies were at the end. Then they had the working men's dwellings in flats, something after Mr. Peabody's style; and then there were the working men's dwellings built in the south, under the general provisions of the

health regulations, in which were, perhaps, four bedrooms and two rooms on the ground floor, with a scullery. He considered those very objectionable, because the rents were so high the poor people could not pay them without sub-letting. The consequence was that generally two or three families lived in the same house, and all sorts of evils resulted, the worst of which was the sanitary condition of the place. He mentioned this matter in the hope that some gentleman at a future meeting would read a paper on the construction of workmen's dwellings, because it was a serious question and one yet to be solved, how to provide the working man with a cheap, well-ventilated, comfortable house. With regard to gullies and house connections, if the gullies conveyed any deposit from the streets into the sewers the latter were obstructed by it. They had all sorts of patent gullies; but unless they had a gully of good depth, with a good trap to it, they would not intercept the debris from the roads and other matter. In Leeds he constructed over a hundred miles of sewers, nearly the whole of which were under his supervision. They had gullies there constructed of 6-inch flags, 2 feet square and 4 feet deep. They found the 6-inch flag stopped from time to time, and they substituted a 9-inch one In the whole length of the sewers in Leeds none of them were ever stopped up, except where some breakage or damage occurred, and that proved that no debris had ever come from the surface. If that were so, and the gullies could be so constructed and the connection with the streets so made that the water from the streets could be conveyed into the sewers, would it not be better to have a rainfall into the sewers instead of having a separate system? Mr. Lemon had advocated a constant flow through the sewers. If they had not a constant flow, it was very desirable, especially in wet weather, to have as nearly a constant flow as could be got. If they had a separate system for the sewage alone, they would see that when they flushed the sewers the stench would be very great. He had often been down to the outfall of the sewers in Leeds after a severe storm, and the stench there was something dreadful. That was before water-closets were constructed. The stench was forced through by the rainfall; and if a rainfall could cleanse a sewer so thoroughly, was it not a great advantage to have it? With a good current of air, a good supply of water, and sewers properly constructed on inclined planes and well ventilated throughout, they would have comparatively wholesome sewers.

Mr. Lobley (Hanley) said he had not had any personal expe-

rience of the duplicate system of sewers, and he could not say anything positive against it; but he could not see his way to adopting it in all its phases. It might do very well in sea-coast towns, where the surface washing of the streets could fall into the sea, but in inland towns it was different.

Mr. Proctor (Bolton) said, with regard to making a connection between the sewers and house drains, the difficulty appeared to be in getting the contractors to carry out the work as it should be done, and it had been stated that the work should be done by the Corporation; but he contended that if they could get it satisfactorily done by the builders it would be better. The course adopted in his district for overcoming the difficulty was this. When the notices were sent in they were adjudicated on in the usual way, and notice of approval was sent to the person submitting them; but accompanying that notice of approval were sent forms of notices which the builders were required to give before commencing building, commencing to put in their foundations, and after they had laid their drains, but before the drains were covered up. First, the contractors were expected to give in their notices in the usual way, but difficulty was found in compelling them to do so; so printed forms of notice were sent to them to fill up, and if they failed to send in those notices in the usual way proceedings were taken against them. That was how the difficulty was got over. Some difficulty had been found in carrying out the Artizans' and Labourers' Dwellings Act in Bolton, and people had been deprived of their property without the Corporation having power to compensate them. Power to give compensation had, however, been taken in the Bill of 1872, and this gave general satisfaction.

Mr. Angell (Past-President) wished to add to his previous remarks, that in his district of West Ham, a very large one adjoining the metropolis, no person was allowed to touch the sewers in the streets. The whole of the work done in the street between the sewer and the boundary of the house was done by the local authorities at the cost of those for whom the work was done, but he thought this work should be extended to the interior of the house.

The President said there was one thing which Mr. Ellice-Clark had omitted to recommend, and that was air-pipes from all the traps under the closets. It was, he considered, one great objection to water-closets in private houses that air-pipes were not laid from the traps, because without them the noxious gases got into the house.

Mr. Ellice-Clark, in replying, said Mr. Jones had made a mistake in supposing that he said they ought to have Government Engineers coming down and inspecting their works. What he meant to convey was that all local board surveyors should either pass an examination or stand some other test before they were allowed to carry out extensive works. He considered that essentially necessary, because to his knowledge in the south of England there were a large number of men who held appointments not only as surveyors, but as inspectors of nuisances, who were charged with the carrying out of those works, and who had no sanitary knowledge whatever. With regard to water-closets, he would not insist on their being altogether removed from the houses. He would have the water-closet removed some eighteen inches from the house, with an iron grid to serve as a stop from the house to the closet, so that there should be a free current of air between them. Mr. Harpur said Merthyr Tydfil had decreased in its death-rate. That was true, but he (Mr. Ellice-Clark) only spoke of towns in England. Merthyr Tydfil was one of the towns where the death-rate had decreased since the introduction of water-closets.

Votes of thanks were passed to Mr. Ellice-Clark and Mr. Vawser for their papers.

STREET LIGHTING.

By T. A. SKELTON, Architect.

There are perhaps no places of which it can be fairly said that the Street Lighting is both efficient and economic. There are certainly many in which it is inefficient and extravagant, and considering the influence of Street Lighting upon the comfort and safety of the Urban population, as well as upon the protection of property, this subject may perhaps be deemed well worthy of your consideration.

Gas being at once the cheapest and best of illuminating agents for street purposes, we have only to consider the method of its supply and the means by which we can practically obtain and use the largest amount of its illuminating power.

Where the gasworks are the property of the Urban Authority, the supply of gas is a simple matter, requiring only good burners of suitable size, and lamp governors to equalize the consumption of gas under varying pressures.

But where the gas is supplied by a company, the lamp governor has not been found sufficiently accurate to be a reliable basis of contract, and hence the meter or average meter system has been to some extent adopted; for evidence of its advantages I may refer to a recent Report of the Lighting Committee of the St. Pancras Vestry, which shows that with 3290 lamps, the nett annual saving is £2282, while the actual consumption of gas per lamp has been increased from 3·96 feet per hour, to 4·40 feet.

If, in addition, the Urban Authority owns the street lanterns, and controls the repairing, cleaning, and lighting, then, being able to avoid conflicting interests, and to economize by varying the size of the burner according to the requirements of the situation in which the lamp is placed, the supply of gas may be considered to be in a satisfactory state.

Having, however, obtained the gas under the most favourable conditions possible, we have yet to see that the maximum amount of light is produced from it. The imperfect burners, the heavy,

broken, and dirty lanterns so often seen, with either too much or scarcely any ventilation, are not conducive to the attainment of this object, but are most extravagant, wasteful, and unsatisfactory, *and the false economy of burning expensive gas in inferior and defective lamps cannot be too strongly pointed out.* The burners should have steatite tips, they should be suitable for the quality of gas used, and be replaced immediately when found defective.

The gas referees in their Report to the Lords' Committee of Privy Council for Trade, in 1871, urged the importance of good burners, and stated that "by using good burners instead of bad ones, consumers may obtain from 30 to 50 per cent. more light, while their gas bill remains the same."

The lamp governors and burners must be so proportioned and regulated, as to deliver the gas at the burner, at the pressure best suited to its perfect combustion. The lanterns should have narrow angle bars to avoid heavy shadows, and flaps or slides at the bottom to permit lighting by the torch rod, while to ensure a well-regulated supply of air, there should be small openings at the bottom corners, perforations in the metal eaves bars, and a good outlet at the top for the escape of the heated air.

If the outlet is insufficient the glass soon becomes smoked, the roof glass is fractured with the excessive heat, and the lantern framework is more quickly destroyed. While, on the other hand, if the bottom is left entirely open, even a slight wind renders the flame unsteady, greatly reducing its illuminating power and often extinguishing the light.

The forms of ordinary gas street-lanterns are too numerous to permit here any full description of them, but the classes into which they may be divided are :—

1st. The plain 14-inch square lantern, with flat glass or metal roof.

2nd. Ornamental square lanterns, with flat or bent glass or metal roofs.

3rd. Ornamental lanterns, with bent glass or glass globes.

But so far as the power of illumination is concerned there is little difference between them, and the rule appears to be to select the cheapest, the plain 14-inch square lantern. Yet a well-designed ornamental square lantern need cost but little more, and should certainly be preferred; but unfortunately the ornamental forms of lanterns are often designed for appearance by daylight, with little

regard to the obstruction of light caused by their heavy metal frames and massive brackets.

The lamps formed of glass globes give but little shadow if suspended or fixed with thin supports; but this advantage is hardly worth the greater cost of these lamps, and the expense of wholly replacing the glass globe if broken, repair being impossible. In fact, only flat glass should be used in street lanterns, where economy is studied.

We may then consider the following as essential elements in obtaining efficient street lighting :—

1st. The ownership of the gasworks or the meter system for the supply of gas.
2nd. Lamp governors and good burners for its consumption.
3rd. Square-framed lanterns with narrow metal framework, flat glass, and well-regulated air supply for the protection of the frame.

Under such circumstances the maximum of light will probably be produced at a minimum of cost, and by a sufficiently large consumption of gas we shall have *efficient* street lighting; but it will not be *economic;* an enormous percentage of the light produced will be wasted; in fact, of the light radiating above the level of the flame (half the light produced) very little, if any, will be utilized. This waste is certainly extravagant, and if prevented, then far less gas would produce the light required in the street.

This serious defect in street lighting is generally admitted. It is evidenced by the glare above large towns, which must have been observed by you. The traveller approaching the metropolis at night fully realizes the truth of the Poet Laureate's description, and

"Sees in heaven the light of London, flaring like a dreary dawn."

The attempts to utilize this wasted light have indeed been many; reflectors have been placed in the lantern roofs, throwing back the light into the lantern (Fig. 5); opal glass roofs, radiating light in all directions (Fig. 3); lenses and solid reflectors, scientific and otherwise, have been tried and have failed; it being useless to intercept this light, unless it could be diverted into the intervals of darkness in the street; and until the introduction of the Catoptric Reflector (Figs. 2, 4, 6, 7, 8, 9), the real utilization of this wasted light seemed practically impossible; but with these new reflectors, so

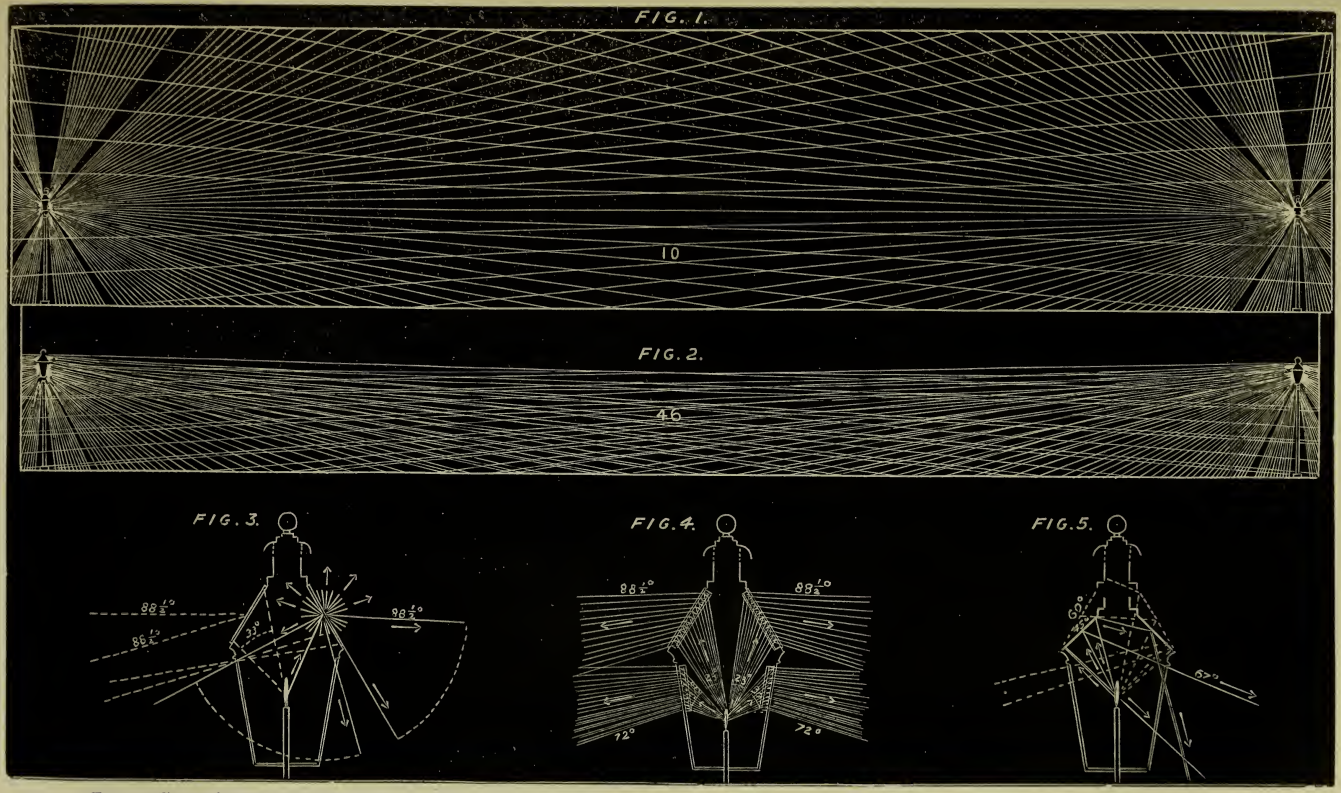


FIG. 1.—Shows the radiation of light from two common street lamps, 45 yards apart, each line representing 1°, the centre space receiving only 10° out of 360°.
„ 2.—Shows two catoptric lamps at the same distance, the centre space receiving 46°.
„ 3.—Shows a lamp with opal glass roof, each intercepted ray of light being dispersed over 360°.
„ 4.—Shows the double reflector catoptric lamp.
„ 5.—Shows a common lantern with solid reflectors, reflecting light back into and through the lantern in single or double reflections.

different in principle from all others, success has undoubtedly been achieved, and at last it is within our power to utilize nearly all the light produced, thus securing economy in addition to efficiency.

Fig. 6.

Fig. 7.

Single Reflector Catoptric Lamp.

Fig. 8.

Fig. 9.

Double Reflector Catoptric Lamp.

The principle of these compound Catoptric Reflectors is to allow the light to pass through them, merely diverting the direction of the rays of light into the desired course. This reflector has been introduced to public notice under the name of the Catoptric Lamp. The first pattern (Figs. 4, 8, 9) has reflectors in the sides as well as in the roof of the lantern, and it utilizes to the utmost practical extent the otherwise wasted light. The new pattern (Figs. 6, 7), designed to fit into the roof of the lantern only, can be easily applied to existing lanterns, and requiring only half

the number of reflectors, entails only one-half the cost of the original pattern.

It does not, however, intercept quite so large a proportion of the wasted light, but, as a result, it doubles the illuminating power of the flame in the intervals between the lamps.

The simplicity and power of this reflector, and the ease with which it can be added to lamps now in use, will commend it to your attention. Examples of both patterns are here before you, and you may observe the effect of them in use in Portland Street in this city (Manchester).

The Catoptric Reflector is applicable to every form of out-door lamp, but the best results will be obtained in lanterns whose roofs slope at an angle of 60° from the horizontal line.

The economy of using the reflectors is evident, if we consider the large annual cost of the gas used in a street lamp, and the small annual cost of these reflectors. Thus assume that two-roof reflectors are placed in a lantern at a first cost of 12*s.*, say, equivalent to 2*s.* per annum for six years. Add interest upon the capital, say 4*d.*, and for repair beyond the usual breakage of glass 8*d.*, and we have a total annual cost of 3*s.* per lamp; compare that with the 3*l.*, 4*l.*, or 5*l.* per annum paid for gas, and it must be admitted that the economy of their use is fully proved, if at so small a cost the illuminating power of the street lamps can be doubled or even largely increased at the spot where the greatest deficiency of light usually exists, that is, in the intervals between the lamps.

Where the street was sufficiently well lighted before the addition of these reflectors, then 20 to 30 per cent. may be saved on the gas bill, and yet the street will be as well, indeed, better and more evenly lighted; and where more light is desired, in what other manner can it be obtained so cheaply?

Permit me, then, in urging upon you the importance of good street lighting, to claim your attention, in the first place, to the production of the maximum amount of light from the gas consumed; and, secondly, to the utmost utilization of that light by the use of Catoptric Reflectors.

In conclusion, let me beg you, while considering and dealing with this subject, to keep the prime object of a street lamp steadily in view, and to use your influence to prevent its being made, under the guise of improvement, a mere daylight ornament, or its light being obscured by street name indicators (names that could, per-

haps, be read as well if fixed to the nearest wall, suspended to the ladder iron, or placed on the base of the lamp standard), and I feel confident, that if the suggestions I have now ventured to put before you should receive your approval, and be carried out by you in practice, you will have the credit of obtaining for your towns the great advantage of both efficient and economic street lighting.

---

1. Cost of applying Catoptric Reflectors to Street Lamps.

	£	s.	d.
Say two reflectors at 6s. each	0	12	0
„ placing the reflectors and altering height of burner	0	1	0
Cost per lamp	0	13	0

2. Annual Saving to be effected by using Catoptric Reflectors.

Gas consumed in each lamp at 5 feet per hour, say 20,000 feet per annum, at 4s. per 1000, or 4d. without reflectors: then using only 4 feet per hour with catoptric reflectors, will give better lighting, and save				0	16	0
Deduct the annual cost of reflectors, say 13s. extended over 6½ years	£0	2	0			
Interest upon outlay	0	0	4			
Extra repairs, say	0	0	8			
				0	3	0
Total annual gain per lamp				0	13	0

3. Gain in Lighting Power by using Catoptric Reflectors.

In comparison with an ordinary street lantern, a double reflector catoptric lamp gives an equal light at nearly twice the distance.

A single reflector catoptric lamp gives, at twenty or thirty yards' distance, *double* the illumination given by a plain lantern.

Catoptric reflectors ensure a more even diffusion of light throughout the street.

SALFORD MAIN DRAINAGE.

By Mr. ALFRED M. FOWLER, M. Inst. C.E.,
Borough Engineer, Salford.

The providing of main arterial sewers for the borough of Salford has for some time past been under the consideration of the corporation. At present there are forty-nine sewers conveying the sewage from the inhabitants of the borough into the River Irwell. Several schemes have been devised from time to time with the view of intercepting all the sewage flowing from these outlets, some designers advocating but one main sewer, whilst others recommended separate sewers for certain districts. These schemes varied *remarkably* in design, as to the capacity of the sewers, mode of construction, and direction. Some schemes involved tunnels 30 feet below the surface, whilst others suggested a line having a depth of 74 feet from the surface.

Many of the old sewers, after the plan of Captain Vetch, were recommended to be abolished, and small pipe sewers substituted. These various schemes were brought about in consequence of the borough being divided into three districts, each district having separate jurisdiction, certain things amongst other matters the sewage works.

In the year 1872 a portion of the main sewer for the Salford district was constructed, when I was appointed Engineer and Surveyor for the borough, in place of the three District Surveyors. The whole of these schemes were then handed to me to report upon, as to the best plan to be adopted, when I advised that the best and cheapest course would be to have but *one main trunk* sewer for the whole of the borough. This report obtained the unanimous approval of the corporation. The work then constructed was taken up and altered accordingly. By this means every part of the borough, eight square miles in extent, can be provided with deep sewers, and good workable inclinations, none of the schemes previously designed provided for this. The saving by adopting this one main trunk scheme in preference to the other proposals is estimated to be upwards of 11,000*l.*

To obtain this important object, the invert of the sewer at the outlet is fixed a few inches below the ordinary water-line of the river, and is passed under the river in two places, at points about three and three-quarters and four and a quarter miles distant from the outfall. These crossings under the river will be formed of cast-iron socketed pipes, 2 inches thick, having flanged joints at the junction with the brickwork. The sewer at the first crossing is designed to be equal to a circle 5 feet diameter, reduced to 2 feet 6 inches in height for about one-third of the width of the stream, the pipes being extended laterally, to obtain the required capacity, gradually varying in size by irregular-shaped castings to join the flattened portion in the middle of the river and the brickwork at each end of the culvert.

The forty-nine outlet sewers at present existing are very objectionable, for many reasons, principally in consequence of the sewage flowing on to the banks of the river in dry seasons, and thus passing along the river course through the town. Every outlet into the river at present forms a means by which the flood waters of the river are admitted into the cellars in the lower parts of the town. At every flood the sewers are silted up to a certain extent, causing damage and inconvenience, especially in the poorer districts of the town. The deposit in the sewers arrests the free flow of sewage, and filth accumulates if attention is not given to them.

The sewer commences at a point on the right bank of the River Irwell, about a quarter of a mile below Mode Wheel Mill, following the direction of the river and nearly parallel thereto for a distance of about three and three-quarter miles to Sussex Street, in the township of Broughton, thence for a distance of about one mile, partly in the township of Pendleton to its termination.

The depth of the sewer below the surface of the ground varies from 10 feet to 40 feet. The size is 7 feet 6 inches by 8 feet 9 inches at the outfall, terminating at about four and three-quarter miles from its commencement, 3 feet diameter. Upwards of two miles of the work has been completed, by means of open cutting 19 feet deep, and two tunnels about half a mile each in length. The works now in progress are being executed by means of tunnelling about 31 feet from the surface. The strata met with in the open cutting was composed of quicksand, gravel, and soft rock; that in the tunnels principally red sandstone rock and some hard clay.

During the operations large quantities of water have been met with, and heavy pumping machinery has been employed, which, together with the hardness of the rock, has sowewhat checked at times the progress of the works. At one period not more than about 16 inches per day of twelve hours could be advanced. Burleigh rock drills were then applied, and upwards of 3 feet were accomplished. By this process a number of holes are drilled in the rock so as to remove the material in sections. The holes are charged with dynamite, and fired simultaneously by an electro-magnetic apparatus, the electric machine is placed on the top of the shaft, wires are attached to the battery, and by one turn of the handle all the shots can be discharged at once. Dynamite is considered to be much safer than gunpowder: it is not injured by wet. The Burleigh rock drills were worked by a six horse-power engine placed on the surface of the ground, near the top of the shaft, with iron pipes 2 inches diameter (similar to gas pipes), connected to a pump which worked the drills at the rate of 1 foot per minute. A great advantage is obtained by this arrangement over the ordinary method of blasting the rock by hand drilling and the use of gunpowder. The tunnel by this arrangement was well supplied with fresh air, which cleared away the fume caused by blasting. This was of great advantage to the workmen, and a great saving of time, by not having to wait until the smoke cleared away, as in the case of gunpowder blasting. Yet the contractors have been obliged to fall back upon the old method of using gunpowder and hand drilling. Although the designs were got out for the use of brickwork throughout the entire length of the sewer, the rock met with, in many places, has been found to answer the purpose quite as well, where faults or seams have been met with, brickwork has been inserted.

Brickwork is also used where the crown of the tunnel is found to be faulty, the rock being there cut on the bed. The invert and sides are neatly dressed off to the proper section and a set-on cut to form a skew-back for the arch. A great quantity of this work is finished, and the remainder is now progressing satisfactorily.

As before stated, the size of the sewer at the outlet is equal in area to a circle 8 feet 6 inches in diameter, and is calculated to discharge the rainfall during an extraordinary thunderstorm. Self-acting flood doors are also provided for, so that, in the event of the sewer ever becoming overcharged, the water

will pass off into the river. I have estimated the works for the construction of the intercepting sewer at 72,000*l.*, and so far as the contracts have been entered into, this amount is not likely to be exceeded.

No accidents of a serious nature have occurred, although narrow escapes have been witnessed: one in the case of a boy who fell down a shaft 38 feet deep without being injured. Another case worthy of note was the explosion of about twenty-five pounds of gunpowder at the bottom of one of the shafts on the line of tunnel, during a thunder-storm. The lightning at the time was very vivid, and it is evident that the electric current passed down the shaft and ignited the gunpowder. The powder magazine was at this time underground, about 80 yards distant from the point of explosion. The storage of gunpowder has recently been arranged for underground, and it was in the operation of carrying the powder up the shaft for the purpose of making cartridges when the accident occurred.

Vote of Thanks to the Mayor of Manchester.

Mr. Angell (Past President) said as the indoor proceedings of their meetings were now at an end, there was one motion he should like to make, and he was sure it would be received with great cordiality. It was that the best thanks of the Association be given to his worship the Mayor for his great kindness and courtesy in placing that room at the disposal of the Association, and for the general attention he had shown them during their visit to Manchester. It was one of the most gratifying features of the Members that wherever they went they were kindly recognized and received by the municipal authorities. In each of the towns they had visited, whether in their annual and district meetings, they had had the presence of the Mayor or leading members of the local authorities, but in no place had they received more attention or had more reason to be gratified with the municipal authorities than in Manchester. They had had a very successful meeting, and in all respects they had reason to congratulate themselves on its success.

Mr. Jacob (Barrow-in-Furness) seconded the motion, which was passed unanimously.

The President said, he had just seen the Mayor, and his worship

was very sorry that he had been obliged to leave the room. He desired him (the President) to say that his heart was with the Association in all its work; he wished them every success, and he had been only too glad to afford them the facilities he had done. He (the President) could not close without thanking the Association for their kind attention to everything that had passed, especially for their consideration to himself. As a new Chairman and new President he had required all the support they had been kind enough to give him.

Vote of Thanks to the President.

Mr. Ellice-Clark (Ramsgate) said before they concluded the meeting, it was a duty incumbent on them to pass a cordial vote of thanks to their worthy President. The way in which the business of the meeting had been managed could have been accomplished only by a gentleman of most mature experience, and there could be no doubt, from the way in which Mr. Lynde had commenced his presidental year, that he would do well for the Association. He proposed that the cordial thanks of the Members of the Association be given to Mr. Lynde, for having occupied the chair so ably and so well.

Mr. Richardson (Tranmere) seconded the vote of thanks, which having been carried unanimously, the indoor proceedings came to an end.

VISITS OF THE ASSOCIATION.

In the course of the afternoon, July 2nd, the Members of the Association visited a number of places of interest in Manchester and Salford. A short time was devoted to an inspection of some of the self-acting water-closets in Salford, described in Mr. Fowler's paper, which met with general approval. One of Mr. Haworth's mills was next visited; after which a visit was paid to Mr. C. Elcock's works in the town yard in Salford. Mr. Elcock conducted the visitors through his works and explained the various processes as he went along. He first pointed out the material out of which the streets-sweeping charcoal was made, stating that it consisted of the sweepings just as they were collected from the streets of Salford. He said the managers of the works had nothing whatever to do with the collection of the sweepings. All that was done was to give the official in charge of the town yard notice that a supply of sweepings was wanted, and he sent in just what he thought fit. From that material, sometimes dripping with wet, the charcoal was made. The shed under which the works were carried on belongs to the corporation, who allowed him to put his plant in there, and though they sold the sweepings to other people at 1*s.* per ton, they kindly let him have them at 2*s.* per ton. (Laughter.) The night-soil, which the corporation sold to other people at 2*s.* or 2*s.* 6*d.* a ton, and paid carriage for it wherever it had to go, they only charged him 4*s.* a ton for. Mr. Elcock conducted the party through the works, and explained the construction and working of the machinery, and said, when the charcoal was made, it was sold to parties who wanted it for deodorizing purposes, or for dry closets, or such like. When the company commenced operations, they were unwilling to put a price on the manure themselves, not knowing really what it would fetch, and so they gave away a considerable quantity of it at first. At last, finding that the farmers valued it at that price, they put 10*s.* a ton on it, which they gradually raised, until last year they sold it at 25*s.* a ton, and the price now was 35*s.* a ton. The company did not cart it away. One ton of charcoal was usually obtained out of

two tons of this material. It depends greatly on what the street sweepings are composed of, but 50 per cent. is the average proportion. A single ton of charcoal would deodorize almost any quantity of night-soil. Generally about two tons of charcoal was mixed with one ton of night-soil, which was enough to make it sufficiently dry to stack it up. The matter did not heat in drying, unless it was turned over and so exposed to the air, and then it would get warm.

Mr. Elcock also explained in detail the working of portions of the machinery.

The Members of the Association next visited the Abattoir in Water Street, Manchester, over which they were shown by Mr. Page, the chief superintendent of the market; and afterwards the town yard of Manchester, *adjoining the Abattoir*, where the process of utilizing the street sweepings and excreta, already explained by Dr. Leigh, was shown in operation.

The Members also visited the chief fire-brigade station, where the brigade were put through various evolutions.

On the following day, July 3rd, visits were made to the Manchester Water Reservoirs, Woodhead, the new Town Hall, Police Stations, and Gasworks.

This concluded the second most interesting and successful Annual Meeting.

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DISTRICT MEETINGS

OF THE

ASSOCIATION.

DISTRICT MEETING AT BARROW-IN-FURNESS.

The District Meeting of the Members of the Lancashire and Cheshire branch of the Association of Municipal and Sanitary Engineers was held August 7, 1874, at Barrow-in-Furness, in the Mayor's Parlour, that room having been placed at their disposal by his Worship. Mr. T. C. Thorburn (Birkenhead) occupied the chair.

The routine business of the meeting only occupied a few minutes, and after it had been disposed of, the Chairman called upon Mr. A. Jacob, B.A., Borough Surveyor (Barrow), to read a paper, chiefly historical, with reference to the rise and progress of Barrow-in-Furness. It would no doubt be interesting to all Engineers, the Chairman remarked, to see that the Council of a new borough like Barrow should have taken such enlightened views with the object of laying out a model manufacturing town. Barrow lay very near the land-marks and footholds of their forefathers, but still it was a commercial and industrial centre. Efforts well-directed were being put forth to make Barrow an important sea-port; it possessed many advantages for this, not the least of which was the Channel, which had been converted into docks, lying between Barrow Island and the mainland. He thought the progress made by Barrow during the last few years showed the spirit and enterprise of the parties who directed its trade, and he was certain it could not be otherwise than interesting to hear some account of this remarkable progress.

Mr. A. Jacob, who explained that his paper was necessarily more historical than otherwise, proceeded to read the following:

The borough of Barrow-in-Furness occupies the westernmost portion of the Peninsula of Furness, and comprises the Islands of Walney, Foulney, and Piel, with the area of water that lies within their circle. Including land and water the borough covers an extent of 14,940 statute acres, the area of the land above high water being 8157 acres. The character of the country is undulating, the surface varying in height from 100 to 280 feet above the level of the sea. Geologically, Barrow is situated on the red sand-

stone of the magnesian limestone series, over which lies a layer of boulder clay varying in thickness from a few feet to 100 feet or more. The remarkably rapid growth of the town and its material development generally may be said to be without parallel in the annals of the United Kingdom, or indeed in the history of any other country, if some of the modern cities of America be excepted. In the year 1849, just twenty-five years ago, Barrow, so far as relates to its present position and prospects, may be said to have had no existence. It is true that there were a few farmhouses and a few dilapidated cottages situated on the mainland, close to where the road to Barrow Island now crosses between the Devonshire and Buccleuch Docks, but the total population of the houses could not have exceeded 200 people. Near to the village were erected, for the shipment of iron ore, a few timber stages, approached by tramways from the shore or by a cartroad across the sand. Until the year 1845 there was no better communication from the neighbouring iron mines to the coast than by ordinary carts, and the shipment of ore, although at that date not inconsiderable, was a comparatively slow and difficult process. In 1844 the Furness Railway Company obtained parliamentary powers for the construction of a line from Kirkby Ireleth to Lindal, both villages in the mining districts, with a connecting line from Dalton to Barrow. The principal object of the undertaking was to connect the iron mines in the neighbourhood and the slate quarries at Kirkby Ireleth with the coast, at the two points best adapted for shipping, viz. Barrow and Rampside; but even as early as 1845 there was an expectation that the line would at no distant time come into use for passenger traffic. The following year the company went to Parliament for powers to extend their line northward to Broughton-in-Furness, and eastward to Ulverston; and meanwhile the Whitehaven and Furness Junction Railway Company obtained an Act enabling them to construct the present coast-line, so as to open up traffic with Carlisle and Scotland. This connection it was justly predicted would prove of the utmost importance to the Furness Company. In the year 1848 the line was completed to Broughton, and the Railway Company purchased steamers for the purpose of establishing a communication with Fleetwood. The extension to Ulverston was not completed until 1854, about which time Messrs. Schneider and Hannay, the owners of some of the richest mines in the district, commenced running steamers to South Wales. For some time a project had been under consideration for

a connecting line of railway from Ulverston to Lancaster, and in the year 1857 the line was opened for traffic. This undertaking completed, the connection of the Furness Railway system with the London and North-Western system, and a final branch line from Carnforth to Wennington, united the line with the Midland railways. From this time dated the commencement of a new era for Barrow. The greatly increased exports of iron ore attracted vessels of larger tonnage to the port than had heretofore engaged in the trade, and the construction of docks followed as a necessary consequence. In 1863 a Bill was introduced into Parliament for vesting Barrow Harbour in the Furness Railway Company, for transferring to the company the powers of the Barrow Harbour Commissioners, and for enabling the company to construct a dock. The physical circumstances of the locality were eminently favourable to the undertaking, and Messrs. McClean and Stileman, the engineers to the company, were not slow in availing themselves of the natural advantages that they found at their disposal. They resolved to close Barrow Channel at both ends, and to build the Devonshire and Buccleuch Docks in the space between Barrow Island and the mainland. This work was commenced early in 1864, and the Devonshire Dock was completed in three years. Whilst the Railway Company were carrying out these several operations for promoting the trade of the port, they were engaged in erecting houses for their employés, and the actual growth of the town had commenced. In 1859, Messrs. Schneider and Co. commenced the erection of blast furnaces at Hindpool, those which have since passed into the hands of the Barrow Hematite Steel Company, and this project necessarily gave employment to a considerable number of operatives, so that in 1861 there was a population of about 3000. Five years previously a considerable extent of land was laid out for building on a plan which, although somewhat modified since, has formed the basis upon which the town has commenced and continued to grow. Too much praise can hardly be given to those with whom rested the laying out of the town, and the administration of matters on behalf of the public. Every care was taken to regulate the disposal of new streets and to control building operations, so as to secure for the public a future of health and comfort. Streets were laid out of ample width from 40 to 80 feet, and in some instances to 100 feet wide. As an invariable rule every street has a corresponding back street, 20 feet wide, for approach to the rear of the houses, and in order to secure

adequate ventilation space for the inhabitants. In 1869 a large timber dépôt was established in Barrow, and during the same year the Anchor Line of steampacket ships commenced regular communication between Barrow and the Mediterranean by a line of screw steamers. About the same date the branch line from Barrow to Greenodd and Windermere was opened, and steamers commenced to ply regularly on the Lake. This extension was of great importance in promoting a traffic on the line and an interest in Barrow wholly independent of everything commercial. Barrow and Furness Abbey became at once the base of operations for the great majority of tourists, who were thus brought within much easier reach than heretofore of the beauties of Lancashire, Cumberland, and Westmorland. Every year now showed improvements in the steamboat traffic, and in the dock and port receipts, and the large and constant additions to the Railway Company's rolling stock afforded the most substantial evidence of prosperity. The contemplated establishment of ship-building works, as well as the prospect of a large increase in the timber trade, necessitated the construction of a graving dock, which was completed in 1870. It next became evident that the docks already constructed would require extension, and it was determined to commence the formation of a tidal basin, with a sill 6 feet lower than the present entrance to the Devonshire Dock, and capable of admitting the largest class of vessels at the lowest neap tides. During the year 1871 the large Flax and Jute Works fronting to the docks were completed. This work was projected and carried out in order to meet the want of employment for the female population that was at that time beginning to be felt. The influx of some thousands of artisans and labourers, many of them accompanied by wives and children, added, on the opening of each new work, a very large increment to the female population, and it became not only desirable, but essential, that means should be provided for their employment. With this object in view, the Flax and Jute Works were erected, together with several dépôts throughout the town for supplying women at their own homes with manufactured material to be made into bags. During the same year the Wire Works were completed and commenced work, and the Rolling Mills and Railway Waggon Manufacturing were commenced, both of which have been for about two years in operation. It is unnecessary to remark that the building trade was during all this time in a state of the greatest activity; large firms established themselves securely in business, and extended

their operations and premises to meet the wants of the rapidly increasing population.

So-called speculative builders, too, as might be expected, appeared on the scene almost by scores, to secure a share of the large profits that were being made by the erection and sale of houses. That there was ample scope for speculation will easily be understood when it is stated that large areas of land that were purchased at 3*d.* and 4*d.* per yard have realized as many pounds sterling. The rapidly increasing demand for house accommodation will best be understood by a reference to the population returns. As stated before, the population of Barrow in the year 1849 did not exceed 200 persons; in 1851 it reached 3000; in 1860 it was about 7000; and the census of 1871 fixed the number at 18,245, not including the inhabitants of Walney Island, which was the same year taken into the borough. The present estimate of pupulation as based on the number of inhabited houses is not less than 35,000, and there is no indication at present of the rate of increase diminishing. To show in a more striking manner the rate at which the population has augmented, the number of people increased about fifteen-fold during the three years previous to 1851. During the twenty years between 1851 and 1871 the number increased about six times; and during the three years between 1871 and 1874 the population has almost doubled itself. The rate of increase in the population of a district or town may to some extent be regarded as a fair test of the prosperity of the locality; but when the rental of property is found to advance in a similar or a geater proportion there is the most complete assurance that the elements of permanent success are forthcoming, and are being directed by an enterprising and enlightened policy. The following table shows the increase in the gross rental of the borough for each year since 1870:

1870	£59,995	18	0
1871	73,690	2	8
1872	98,174	18	1
1873	122,934	8	6
1874	143,711	1	6

It is true that in 1873 the Island of Walney was added to the borough, but the rental amounted to a comparatively small sum, property being chiefly land of somewhat inferior quality. Concurrently with the material advancement of the town the spiritual and moral welfare of the community has been carefully provided for, notwithstanding that with so rapid a rate of development there are still many and ever-increasing demands on the liberality of

those whose fortunes are identified with the advancement of the town. Churches, chapels, and schools have been erected wherever and as soon as the necessity for them has become apparent. Within the past year two new schools have been opened by the School Board, and the erection of two more will be commenced within a short time, besides which each of the several religious sections have provided on their own behalf for the worship and instruction of the respective congregations. Having glanced briefly at the circumstances that have influenced the material development of the town, some reference to the administration of sanitary matters will not be out of place. It is hardly necessary now to speculate as to whether the original hamlet was any better or any worse than such villages usually are: its situation on the sea and with a south-western aspect was undoubtedly favourable to health. There were several wells which afforded a sufficient and reputedly a wholesome supply of water to the small community: and if the arrangements for the speedy removal of refuse were not of the most complete kind, the physical situation of the village certainly was not at fault. As soon as the town first began to take its present form it was perceived that permanent drainage works would have to be commenced, and the existing condition of things at the time indicated the adoption of a joint system of sewerage with a free outfall to the sea. Two outfall sewers of brick were accordingly constructed, one from a point near the Railway Station running along the Hindpool Road, and discharging its contents at a point in Walney Channel, near to the entrance to the present Graving Dock, and the other passed down Rawlinson Street, very nearly traversing the lowest line of a natural valley, and so took its course down Salthouse Road and discharged itself into the sea at the natural outlet of the surface water. Simultaneously the detail drainage of the streets and houses was proceeded with, but it only served for the removal of surface water and the least offensive portion of the house refuse. The system generally adopted in the arrangement of the houses was the ordinary midden-closet, with a large open receptacle at the back for the deposit of ashes, and, indeed, of every other kind of dry house refuse. Such a system, although professedly adopted in imitation of some of the large provincial towns in the centre of England, does not in the present light of sanitary science possess one solitary advantage, whilst it presents numerous objectionable features, and is wholly incompatible with the permanent preservation of health. At an

early date in the growth of the town the question of water supply had received consideration, and two reservoirs were constructed in the neighbourhood of Ireleth by a small company, but these were before long found to be insufficient, and in 1864 the Furness Gas and Water Company obtained parliamentary powers for the purchase of the existing works and the construction of a storage reservoir on the Powka Beck, about nine miles from the town. This work was accordingly carried out, and has since afforded a supply sufficient not only for domestic consumption, but to a great extent for manufacturing purposes. In 1867 it was considered expedient to obtain a charter of incorporation for the town, which was accordingly done; and immediately afterwards, by a resolution of the council, the Local Government Act of 1858 was adopted. The following year, however, the council determined to apply for a special Act, which, when obtained, gave them considerably more extensive powers than the general Act of Parliament, and besides enabled them to purchase the gas and water works from the company. In 1872 the council went to Parliament for borrowing powers to the amount of 175,000*l.*, of which 45,000*l.* was intended for sewerage works and street improvements; an equal amount for extension of gasworks; 40,000*l.* for hospital, markets, and slaughterhouses; and 45,000*l.* for burial grounds, labourers' dwellings, and general purposes. Finding that still more money would be required, and that the extension of the waterworks was becoming a matter of pressing necessity, the council resolved again to apply to Parliament, and last year a supplementary Act was obtained sanctioning further borrowing powers to the amount of 106,500*l.*, and authorizing an extension of the waterworks by the construction of additional storage works in the neighbourhood of Ulverston. Extensive street improvements were sanctioned by the Act of 1872, which will probably be carried out in the course of next year; and last year's Act gave the council power, acting in concert with the Furness Railway Company, to construct a high-level bridge across the docks to Barrow Island. This bridge is designed as a substitute for the present road, a somewhat inconvenient subway, and to meet the large increase of traffic anticipated on the completion of the Ramsden Dock and adjoining landing stages. About three years ago, and for some time previously, the Town Council began to realize the necessity for reconstructing their system of sewerage so as to meet the growth of the town, and the writer was directed to prepare the scheme which is now being carried out. There is

in all tide-locked towns more or less of difficulty in disposing of the sewage by gravitation, and Barrow is in this respect no exception to the general rule; the difficulty is, in fact, enhanced in no small degree by the fact that it was designed to invest the whole of the south and east sea-frontage of the town with wet docks; a great part of which design has already been accomplished. It was no doubt possible to carry an outfall sewer direct out to sea at Piel, and so into Barrow Harbour; but the greatest inclination that the levels admitted of did not exceed three feet to a mile, and with such a slope the sewer could not commence to discharge itself until the latter half of the ebb tide, so that the deposition of solid matter in the sewer for a length of three miles would be almost unavoidable, with even the most perfect arrangements for flushing. Further than this, the whole of the sewage discharged during the last hour of the ebb tide and the first three hours of the flood tide would be carried up Walney Channel, and no doubt a considerable quantity of solid and highly offensive matter, after washing the face of the new docks and quays, would be added to the deposits already being formed on the low-lying coast of Walney, immediately to windward of the town. These and other considerations determined the writer to reconstruct the sewerage works as far as possible on the duplicate system. In order to remove the sewage once and for all from the neighbourhood of the town, it was determined to raise it from the outfall by pumping, and either to utilize it by irrigation, or to discharge it into the sea in a clarified condition. In this view of the matter it clearly became imperative that the volume of sewage to be dealt with should be reduced to uniform and manageable dimensions, which could only be done by keeping it separate from storm-water. The objection to duplicate drainage, that of expense, is to a great extent met by the fact that there are already constructed three outfall sewers well adapted for the discharge of storm-water, though not so well suited for the conveyance of sewage, besides a great extent of subsidiary drains, that can be made to do duty with little alteration as surface drains. For these works the main outfall has lately been completed at a cost of about 10,000*l*. A considerable extent of pipe-drainage has also been carried out in connection with extensive private improvements lately completed, and the main connection for the south-eastern side of the town will shortly be commenced. Visitors to Barrow, particularly those who come from ancient and well-established cities, will probably experience a sense of surprise and

disappointment at the unfinished appearance presented by some parts of the town: but a little reflection will render it evident that such a state of things must necessarily exist in a town that is growing so rapidly. The manufacturing interests are increasing every year; more artizans and labourers are required; and it is imperative that every effort should be used to provide adequate house accommodation to meet the demand. The making of streets even—a matter that should naturally precede the erection of dwellings—has to remain in abeyance, because sufficient labour cannot be procured to carry it out concurrently with building operations. There will, under such circumstances, be no difficulty in comprehending why the town of Barrow should look new and unfinished; but, whatever the outward impression conveyed may be, there is a satisfaction, of which every Member of this Association will be sensible, in knowing that the corporation are, in their administrative capacity, actuated only by an honourable desire to regulate and govern the growth of the town on such advanced and enlightened principles as to secure for it in the future a status in every respect worthy of the highest aspirations of its founders.

During the reading of the paper Mr. Jacob frequently referred to admirably executed plans of what Barrow was in 1849, to the first plan for laying out the town, and to a full and comprehensive map of Barrow as it now is, explaining the different points of interest from an engineering and scientific point of view. A discussion arose after the reading of the paper was concluded, and in answer to questions, Mr. Jacob stated that in the double system of sewerage which had been adopted in Barrow, it was proposed, where practicable, to utilize the present sewers for storm-water, as in towns where the sewage could not get clear away throughout the whole day the deposit of sewage amongst storm-water would be intolerable. The corporation had power by their special Acts to make bye-laws as to the width of streets; and the proposal to make main streets 80 and 100 feet wide in the town, and all back streets 20 feet wide, was made with the view of securing the best possible ventilation. The estimate of population now in the town —35,000—was obtained by computing the number of inhabited houses in the town, at a certain number per house, according to a scale which prior to the last census gave almost accurate results. The town was greatly overcrowded at present, and there was not a habitable house to let. Although there was a fall for the sewage of three feet per mile in the town, he had found it desirable to

recommend the pumping of the sewage in consequence of the fact that eight or nine hours out of the twelve the sewers were tide-locked. The double sewerage system was necessary on another account, for if a storm visited the neighbourhood of Newbarns and Hawcoat, and a quarter or half an inch of water fell when a 24- or 25-feet tide was in, the water would not be able to get into the sea, and it would lodge in large quantities in the neighbourhood of Salthouse, which lay low. In all probability the storm-water would be discharged into the docks, but it was necessary to deal otherwise with the sewage itself. There had been no difficulty experienced in the adoption of the system of water-closets in the town, except perhaps in the present period of scarcity in the water supply.

The CHAIRMAN said he had no doubt they would all feel indebted to Mr. Jacob for the kindness he had shown the Association, and for the interesting paper he had read. He (the Chairman) could remember Barrow when it was no larger than was represented in the plan on the walls of the room (1849), and he could call to recollection, as if it were but yesterday, the wooden pier at which coasting vessels were laden with iron ore. The town had had a marvellous growth, and it had very much increased during the last decade. There were only a few instances in England of the same marked development, such as Middlesbro', a town in South Wales, and Birkenhead—the latter having risen to a town of 100,000 people. These towns, in their remarkable growth, resembled American towns. One of the first chains he ever stretched was in this neighbourhood, and to see the town growing in this way was a satisfaction to his early experience. He had no doubt that to see the town prosper was the wish of every one present.

The SECRETARY seconded the vote of thanks to Mr. Jacob for his interesting paper, and for the satisfactory arrangements he had made for their visit to Barrow. He hoped if the Association ever again visited Barrow, they would find it a much larger town than it was at present.

Mr. JACOB, in returning thanks, said it was to the Railway Company and a number of spirited and enterprising gentlemen that the growth of the town was to be attributed.

After the meeting the Members proceeded to inspect some of the large works in the town, with which they were much interested, and subsequently dined at Furness Abbey Hotel.

DISTRICT MEETING AT TOTTENHAM.

The second meeting of the Home Counties District took place on August 14, 1874, under the presidency of Mr. Lewis Angell, C.E.

The Members assembled at half-past eleven at the offices of the Local Board, Tottenham High Cross, whence they proceeded to the sewage works of the Local Board, situate alongside the river Lea. Mr. Clements, the Engineer to the Local Board, conducted the visitors over the works. The engine-house was first visited, and here a remarkably fine horizontal engine, which had just been made and erected by Messrs. Whieldon and Cooke, engineers, Westminster-bridge Road, attracted much attention. This engine, which is of forty horse-power, actuates the pump, which makes about ten strokes per minute, raising sixty or seventy gallons per stroke, the lift being about 12 feet. An ingenious little instrument, called the "Pneumatic Recorder" (Whitehouse and Clarke's patent), registers the number of revolutions per minute made by the engine, so that it is always possible to tell the amount of sewage being raised by the pump. The engine has a somewhat novel arrangement of cams, which allows of the steam being cut off at any portion of the stroke. The sewage comes, black as ink, through the outfall into a small tank or reservoir on one side of the engine-house, into which tank or reservoir a continuous stream of lime and water is poured from a barrel or trough above, the lime being mixed with water by hand, the sewage water itself being used to mix with the lime, owing to water being scarce at Tottenham. From the tank or reservoir before-mentioned the sewage, diluted with the lime and water in the manner stated, flows through a penstock to the pump, by which it is raised to the subsiding tanks. Flare lime is used. Several of the Members took exception to the manner in which the lime is mixed, contending that by the mode pursued at Tottenham it is no deodoriser at all, inasmuch as, not being slaked beforehand, no true hydrate of lime can be formed, and therefore that the mixture as described was mere lime-wash; in other respects the members did not consider the results satisfactory. Mr. Clements, the Engineer

to the Local Board, admitted that the lime was not used as it should be at present, for various reasons, but that in a short time the works would be under different management, as hereafter stated. The subsiding tanks are three in number, parallel to each other, and are built of concrete. Each tank is 300 feet long and 25 feet wide, with an average depth of 7 feet 6 inches. When a tank is filled, the contents are allowed to subside for two days, and the water then flows off into what is known as "No. 4 tank," whence it passes into the Lea — clarified and improved certainly, but (as expressed by several of the Members) still in the condition of sewage, so that it is not difficult to conceive that the river Lea is in a very polluted state. The sludge or deposit is pumped from the bottom of the tanks into large shallow pits, where it takes from six weeks to two months to become comparatively dry and consolidated, when it is mixed with lime and ashes, and used as manure, which, although given away, is not removed with any alacrity by the farmers; indeed, in order to get rid of it a large quantity is now being buried. The process thus briefly described is the old-fashioned lime process imperfectly carried out, but the works are about to be taken over and managed by the Enfield Sewage and Chemical Manure Company (Whitthread's patent) upon the following terms: The Tottenham Local Board will do the pumping, maintain the engine, &c., and pay the Company 200*l.* per annum (the estimated cost of lime), besides allowing the Company to dispose of the sludge, the Company, on the other hand, engaging to find all the chemicals used in their process, and all labour required, and also guaranteeing to meet the requirements of the Lea Conservancy as to the effluent water. When this Company takes possession of the works, the lime will be properly slaked before using, and mixed by machinery now erecting for that purpose.*

After the inspection of the Tottenham works was concluded, the Members proceeded to the Alexandra Palace. A considerable time was spent, under the guidance of Mr. Martin, in examining the principal constructive features of this building, in which, although great progress had been made, much remained to be done.

The Members having adjourned to a room adjoining the great banqueting hall, kindly placed at their disposal by Sir Edward Lee, the chair was taken by the President, Mr. Lewis Angell, and the following paper was read.

* Whitthread's process has since been abandoned.

A SHORT PAPER ON STREET WATERING.

By ALBERT W. PARRY, Assoc. Inst. C.E.,
Borough Surveyor, Reading.

The particulars that I am about to give on the subject of street watering bear chiefly the character of a comparison between the value of two systems of laying on the water; one being by the ordinary water-carts and barrels, and the other by what I will term hand watering.

I have selected this subject mainly on account of the many inquiries that have been made respecting our system of hand watering.

I have endeavoured to be explicit and to give you the necessary particulars in few words.

The watering of the carriage-ways of streets is, as all town surveyors know, a work of necessity in dry seasons, and to do the work most efficiently, and at the same time at the least cost, is a matter of some importance in all towns where the carriage-ways are principally macadamized.

I will take for my present purpose, to illustrate what I am about to say, the borough of Reading, where I am located, and in which there does not exist a paved carriage-way; there are about twenty-three miles in length of public roads, about seventeen of which are watered mostly twice a day; and to do this we have in use eleven water-carts and barrels and four hand-watering machines.

To give the cost, and describe the utility of the two modes of watering, I have prepared the following particulars.

A water-cart will water twice a day a superficial area of 23,849 yards, and for a length watered one width, that means 5962 lineal yards, or for a double width 2981 yards, the cost per day of laying on being as follows: horse, cart, and man, 8*s.*; cost of maintenance of cart, harness, shoeing, &c., 1*s.* 5*d.*; making 9*s.* 5*d.* per day.

With respect to the hand machines, we have in use one of Headly's Drum Machines, and three of special make, somewhat similar to those used in Paris. They are both capable of doing

the same amount of work, and the area of road watered twice a day by one machine is 23,740 square yards.

Headly's machine cost us, five years ago when new, 31*l.* 7*s.* 3*d.*, and the repairs and maintenance since that date have been 22*l.*, or an average of 4*l.* 8*s.* per annum, and is just now almost past repair. The other description of hand machine cost each, when new, about 20*l.*, and the repairs and maintenance have amounted to an average of 3*l.* 18*s.* each per year. They were in use some time before Headly's was obtained, and they will be of use for a long time yet.

The cost of labour per day by the hand machines is for two men, at 2*s.* 10*d.* each, 5*s.* 8*d.*, as it requires two men to work the machine properly, one to distribute the water, and the other to move the machine, and to attach and detach the apparatus to and from the hydrants; add to this 7*d.* per day for maintenance and repairs, will make 6*s.* 3*d.* per day. The quantity of water delivered by the water-carts is 0·51 gallon per square yard, and by the hand machine 1·30 gallons.

It will be seen therefore that the quantity of water laid upon the surface of the road by the hand machine is much in excess of what is done by the water-carts. Having had some years' ex-experience of both the systems of street watering that I have described, I am satisfied that whenever watering by the hand machine can be resorted to, the roads are watered much cheaper and better than by the water-carts, and it is only in narrow streets, where the apparatus would obstruct the traffic, that water-carts are the most useful, and narrow streets of course need the least watering.

A short discussion ensued, the general opinion being that for wide thoroughfares with not too great a traffic, the system of hand watering as advocated by Mr. Parry was the most efficient and economical. The present system of watering roads by means of carts and vans was condemned as cumbersome and expensive, although, under certain circumstances, it was the only means at present available. Bayley's hydrostatic water-van was spoken of as being superior in point of economy to the ordinary water-carts. The system of watering from perforated pipes laid along the edges of the kerbstones, such as Brown's patent, was also discussed, and generally approved of in principle.

The subject of Sewer Ventilation was then briefly discussed. Mr. Angell, Mr. Ellice-Clark, and other Members stating it as their full conviction that the only proper way to ventilate sewers was to have as many openings as possible, unimpeded by charcoal or anything of the kind. Sir Joseph Bazalgette and Mr. Haywood had, many years ago, proved that ventilation by means of furnaces, as adopted in mines, was impossible. It was stated, however, that at Shaftesbury, a few years ago, the main sewer of the town was ventilated successfully by means of a large number of 4-inch pipes, which were carried up against the houses at short distances apart, but such pipes were not used to carry off rainwater from the roofs, or for any other purpose but that of ventilating the sewers.

After the business of the day was concluded, the Members dined together at the Alexandra Palace.

DISTRICT MEETING AT COVENTRY.

The fifth meeting of the District Committee for the Midland Counties was held on Saturday, Aug. 29, 1874, in St. Mary's Hall, Coventry. Mr. Lewis Angell, C.E., President of the Association, occupied the chair. In addition to the Members, the following visitors were also present: Alderman Marriott, Coventry; Dr. Fenton, Medical Officer of Health, Coventry; Mr. F. Wyles, F.G.S., Allesley Hall, Coventry; Mr. Thomas Whitley, Coventry; Mr. William Boon, Coventry; Mr. W. J. Baggally, Assistant Surveyor, Leamington; Mr. John Baker, Assistant Surveyor, Warwick; Mr. A. J. Ingram, Warwick; Mr. A. J. Fairlie, Warwick.

Mr. Pritchard, Engineer to the Warwick Corporation, and Hon. Sec. for the Midlands District, read the minutes of the last meeting, which were duly confirmed. He also read letters from several Members expressing their regret at not being able to attend the meeting.

The Hon. Secretary then read a letter from Mr. Rawlinson, C.B., C.E., the former part of which was not for publication, but which dealt with the question of the defecation of sewage by chemical processes. In the latter part of the letter he said that he thoroughly approved of the Association, and hoped it would prosper and become a power in the land.

The Members then, under the leadership of Mr. Purnell, City Surveyor, Coventry, paid a visit to the silk factory of Mr. T. Stevens, and also to the watch factory of Mr. Wallen, the works in each instance very much interested the Members of the Association and the visitors. They then returned to the Craven Arms Hotel, from whence they were conveyed to the Sewage Works, at Whitley, where they were met by Mr. Melliss, C.E., Engineer to the Company, and Mr. Coddington, the manager of the Coventry works, acting on behalf of the General Sewage Manure Company. The Members were taken over the works, and various steps in the process were explained in detail by Mr. Coddington, the Members of the Association asking a number of questions, which were freely and courteously

answered. The effluent water was seen under very unfavourable circumstances, owing to the violent storms which had occurred during the morning—one, in fact, a very short time before the party reached the works. In consequence of this the outflowing water was mixed with a considerable quantity of mud, and presented a very dark appearance, which tended to unfavourably impress the visitors with the efficacy of the process. Mr. Coddington bravely battled against the adverse circumstances, and strove in every way to show that the dark colour of the water had no bearing whatever upon the general mode of treatment adopted; but it appeared that after all his efforts an impression was left upon the minds of the majority of those present less favourable than probably would have been the case if the water had been clearer.

The Members were then driven to the Waterworks at Spon End, where the Diamond Boring Company are engaged in sinking a shaft for a further supply of water. When the Members reached the works the drill was not working, in consequence of an accident. After waiting some little time operations were commenced and watched with considerable interest for a few minutes, the Members crowding the small platform to get as near a view as possible of the action of the machinery. At this point what might have proved a serious accident occurred. The large wheel over which the strap from the fly-wheel passes suddenly broke in two, one half falling with a terrible crash to the platform, coming very near to several of the gentlemen who were standing there, and so near to one that it tore a large rent in a coat which he was carrying upon his arm. This of course stopped all further operations. The process adopted by the Diamond Boring Company was explained in detail; and subsequently the party adjourned to a quiet part of the grounds, where Mr. Purnell, City Surveyor, read a paper, containing a description of the City Waterworks, and the various borings.

DESCRIPTION OF THE COVENTRY WATER-WORKS.

By E. J. PURNELL, City Surveyor.

The water supply of Coventry is derived from four artesian wells, sunk in the new red sandstone. Two of these wells are 75 feet deep: one, 195 feet; and one, 300 feet; the strata passed through being alternate beds of sandstone and red marl. The dimensions of the two deepest borings are as follows:

No. 1 Well, 195 feet deep, completed November, 1856.

Cast-iron pipes	25 feet	..	12 inches diameter.
„ perforated	112 „	..	8 „ „
„ „	58 „	..	7 „ „
	195 feet.		

No. 2 Well, 300 feet deep.

Brick shaft	23 feet	..	6 feet diameter.
Cast-iron pipes	18 „	..	2 „ „
„ perforated	130 „	..	15 „ „
„ „	20 „	..	12 „ „
Open borehole	42 „	..	12 inches „
„ „	67 „	..	6 „ „
	300 feet.		

The last-mentioned boring was completed in September, 1860, and the increase in the supply from it was 240,000 gallons per day; the total quantity obtained from the four borings being at the present time about 600,000 gallons per day. In addition to this about 60,000 gallons per day are obtained from two surface springs, and about 60,000 gallons per day from a small brook, called the Barley Brook, which is filtered before use. The water from the wells rises in a circular brick tank 100 feet in diameter and 16 feet deep, and from thence is pumped through a 14″ main to a service reservoir 100 feet high (and over a stand pipe 42 feet higher to supply the more elevated parts of the city) by a 60-horse power condensing engine. There is also a 40-horse power Cornish engine at the pumping station, which some years since was powerful

enough to pump the water required for the city; but in 1857 the increase in the consumption had become so great that it was found necessary to have more engine power, and in 1858 a new engine was put down; since then the consumption has steadily increased. In consequence of the long drought this spring and summer the corporation have made arrangement with the Diamond Boring Company (under the advice of Mr. Hawksley) to sink an additional well 8 in. in diameter to the depth of 400 feet, if they do not find water before arriving at that depth, and, as you have to-day seen, the boring is progressing.*

"The number of houses supplied at the present time is 8010, and the number of water-closets 4300; no charge being made for these unless they are on the first floor.

"The total cost of the works has been 33,000*l.*

"The following is the analysis of the water, made by Professor Miller, King's College, by order of the Lords of the Privy Council, August 20, 1860:

Hardness, before boiling (Clark's scale)	10° 9′
„ after boiling one hour	3° 7′
Specific gravity	1000° 18′
Solid contents in grains per imperial gallon—	
Fixed salts	17·76
Volatile and combustible matter	1·44
Total solid matter	19·20
Nitric acid	0·16
Ammonia	0·86
Cubic inches of gas per gallon—	
Carbonic acid	9·13
Oxygen	1·65
Nitrogen	4·44
Total quantity of gas in solution	15·22

Proportion of oxygen to nitrogen, 1 in 2·69.

"The average annual quantity of water for the last ten years has been 235 million gallons, and the consumption of coal during that period annually 680 tons.

"The whole of the works were designed and carried out by Thomas Hawksley, Esq."

Mr. Pritchard said he had received a letter and paper from Mr. Greatorex, the late Surveyor to the Coventry Local Board, the

* The boring was discontinued at 410 feet, an additional quantity of 160,000 gallons per day being then obtained.

latter being, as he said, a supplement to what had just been supplied by Mr. Purnell, inasmuch as he (Mr. Greatorex) was the Surveyor at the time the previous works were carried out. This paper really did not contain any specially new facts. In one particular, Mr. Greatorex's figures did not quite harmonise with Mr. Purnell's; but a few questions from some of the gentlemen present elicited from Mr. Purnell an explanation, which showed that the difference arose from several circumstances, which did not affect the main issue. Mr. Pritchard also read a portion from the returns he had obtained in connection with the Haseley Water Scheme from a large number of towns, as to the quantity of water supplied per head of the population, Coventry standing at 19, Leamington 22, Warwick 25, and other towns, some sinking as low as 6, while others amounted to 70 gallons per day.

Mr. Angell, the President of the Association, expressed an opinion that the return read by Mr. Pritchard was a most valuable one, and he thought it would be very desirable if Mr. Pritchard would reproduce his paper, so that it might be printed and circulated amongst the Members.

Mr. Pritchard intimated that probably at their next meeting, if it was the wish of the Association, he would bring the subject forward in the form of a paper, and so introduce the information which was contained in this return.

The party then inspected the engines, the various points of which were explained by Mr. Purnell, and then returned to St. Mary's Hall to discuss the Coventry sewage process.

SEWAGE WORKS.

Mr. Melliss, Engineer of the General Sewage and Manure Company (Dr. Anderson's Sulphate of Alumina process), who was invited by Mr. Angell to introduce the subject, said:

You have to-day had an opportunity of inspecting the buildings and machinery with which the General Sewage and Manure Company are dealing with the sewage of Coventry, with a view to the purification of the river Sherbourne.

It has afforded me much pleasure to explain to you the various parts of the works, but I doubt if it would be complete without giving you also a few statistics in connection with the undertaking.

I think much harm has been done, and the solving of the great sewage problem greatly retarded, by a want of unity amongst those

who are really seeking the public good in this matter. There are other reasons also why more progress has not been made, and amongst them I would mention the constitution of the sewage question into a commercial one, with the idea that large fortunes were to be made directly from the sale of sewage manures. This has caused much disappointment, distrust, and discouragement. The manner, also, in which rival schemes are pitted against each other, the promoters entirely forgetting or losing sight of the fact that each locality and town must be dealt with on its own peculiar circumstances, and that however well any one plan may answer in one place, it would be an entire failure, perhaps, in another; and lastly, though not least, I would allude to amateur chemists and amateur engineers, who have done more to retard matters than anyone else.

I trust that you will agree with me in thinking that in our Coventry undertaking we have ascended the ladder of progress by a few steps. It is the first instance of any town in the United Kingdom having got over the sewage difficulty through the application of a precipitation process. Many attempts have been made to deal with portions of the sewage of a town, but it is a very different matter when the whole of the sewage, night and day, is dealt with; for the flow of sewage, like time and tide, waits for no man.

The fine weather average flow of sewage from Coventry, which has a population of 40,000, amounts to 1,800,000 gallons in the day of twenty-four hours. As you have seen, the first process is that of mechanical straining of the sewage; the second is the admixture of the principal chemicals; the third is the admixture of a small quantity of milk of lime; the fourth is the precipitation of the solid matter; and the fifth is the drying of the sludge into an agricultural manure.

The sewage of Coventry yields about five tons of dry manure daily, and this is chemically valued at 3*l.* per ton. Of course the demand for the manure must be gradual, more especially as there is a large number of persons who have no faith in sewage manures. For my own part, I can only say that a few years ago I also was sceptical on this point, but since I have observed the effects produced upon crops through its application at Whitley farm, I am quite sure that it possesses valuable fertilizing qualities.

The Coventry works have only been in operation four months,

so that it would be premature to produce any statistics as to the cost of working; but this I feel I may safely say, that if all the manure finds a market at its stated value the returns will be larger than the expenditure. I would at the same time advise local authorities not to rely too much upon the returns, but first seek to deal with their sewage as they do with any other portion of the municipal machinery, such as police, roads, sewers, &c., and then endeavour to make as much as possible out of its products.

I think a great deal more would also be accomplished in solving sewage difficulties if more honesty and straightforwardness were shown in the discussion of the matter. I am, therefore, not disposed to hide from you any of our shortcomings at Coventry. Of course, we have our difficulties and our occasional accidents, but we do not try to put a clean face on the works for any special occasion. You will have seen that we are overburdened with sludge. This is in a great measure due to our drying machinery having been out of work more or less during the last five or six weeks, to enable Messrs. Milburn and Company to erect a new sludge filter immediately over two of the drying machines, and to make arrangements for new flues by which the gases arising from the sludge should be burnt instead of escaping into the chimney stack. This is the principal cause why you see so much undried sludge on the premises; though, at the same time, I would mention that the drying machinery is not quite adequate to the rest of the works. I anticipate, however, that with Messrs. Milburn's new filter the present machines will dry four-fifths of the sludge, and that the erection of another drying machine and filter—space for which is provided in the buildings—would dry the remainder.

You will also have noticed that at present the machinery for pulverizing the manure is not yet completed.

In conclusion, I would mention the Nuneaton Sewage Works, which have so prominently figured in the newspapers of late. The Company has hadt hem in operation for two years, but the works are now quite inadequate to deal with the large increase in the flow of sewage, through leakage of river and subsoil water into the sewers; and the question that has arisen is merely whether the Company or the Local Board of Health should enlarge them. I have taken this opportunity of mentioning this, because I am desirous of preventing a valuable process from being marred by a mere question of pounds, shillings, and pence.

Mr. Angell (President) opened the discussion by remarking

that he felt bound to say the works, as works, were well adapted to the purpose to which they were devoted, and reflected great credit upon the Engineer. He was not in a position to express an opinion upon the result of the chemical treatment of the sewage adopted. He hoped he might say they were in a position to approach the subject without prejudice, and he would assure Mr. Melliss that the Association would welcome any attempts to solve the sewage difficulty, whether those attempts came from engineers, chemists, promoters of companies, or any other persons. At the same time, as responsible officials, they felt they could not give their countenance to anything which was brought before them, unless it were proved by due and proper testing. He thought that the company had scarcely been at work long enough to determine the question of the commercial value of the residuum. Speaking from experience, he said that the cost of treating sewage by chemical process was very great. Referring to the district of West Ham (where he is Engineer), he could say that with a population of 80,000, it had been ascertained that for the chemical treatment of their sewage by one process 14,000*l.* a year would be required. This was a very large sum of money to expend upon chemicals, and the most that they were promised was that they might get a result which, if it did not pay, would at least involve them in but little loss. This was of course a very serious thing. He thought the promoters of companies ought to be in a position to prove that the towns would not suffer loss by such a venture. Then there was the difficulty which they had experienced that day, when a large volume of storm-water poured down the sewers, went through the works, and must have washed out a very large quantity of the valuable chemicals which had been deposited in the tanks. These were among the reasons why he thought, as he had at a previous meeting said, the Government ought to take the matter up, and give them some assistance. At present they could get no reliable information from that source whether chemical defecation was the better principle, or to send the sewage upon land. He recommended that a commission should be appointed to test this question. He might say, and it was in favour of Dr. Anderson's process, that three months ago he paid a visit to the Coventry works, and took a sample of the water. He also took, at the same time, a sample of the effluent water from other works, where the sewage was treated upon a different principle. He examined both the samples in three days after taking them;

that from Coventry was pure, while the other was most offensive. He put the bottles away, and on the preceding day had opened them again; that from the Coventry works was still without smell or taste, while the other was in a most offensive state, showing that decomposition had been going on very rapidly. Purification was, of course, a relative term. If the stream into which the sewage was poured was not to be used for domestic purposes, obviously it would not need that the effluent water should be rendered so pure as would be requisite in the event of a river being a source of domestic supply. Mr. Angell then passed on to refer to the difficulty of drying, which, he thought, was one of the greatest difficulties connected with the system. He was bound to say he thought Milburn's apparatus hitherto a failure, as it would not dry ordinary sewage sludge excepting at a great cost. They had noticed that day that the sewage was pouring into one of those dryers at one end in a liquid form, while it came out at the other dried by intense heat. But it had struck him in connection with this aspect of the subject whether some absorbing agent could not be discovered and applied: quicklime had suggested itself as such an agent, which, if applied to the sludge, would absorb the moisture and promote the drying process, while it would add to the manure a property which to some lands would be of a very valuable kind. When in the Potteries he had found there was a waste substance—plaster of Paris—and it struck him that the combination of this plaster of Paris with the sludge might effect to some extent the desired end. The great obstacle in all cases was the cost; the application of expensive agents to a worthless subject. He did not think that Milburn's apparatus at all solved the difficulty, and reiterated the opinion that the Government ought to come forward and assist them out of their difficulty. Here they had one authority telling them that nothing would do but to put the sewage upon the land, while another as distinctly affirmed that it was utterly foolish to suppose that any such system as that could possibly do. So that they were in this position: if they followed the advice which was given them by one Government Inspector, they would be immediately sat upon by another. He must say that what he had seen that day tended to convince him more than ever that the sewage must go upon land. They had noticed that the effluent water that passed into the river through the land was comparatively pure, while that which came

from the tanks was much less pure. But whatever might be their opinions upon these questions, he was sure they would all be unanimous in according a vote of thanks to Mr. Melliss for his paper, and for his kindness in attending that day to explain to them the nature of the process.

Mr. Melliss thanked the gentlemen for their kindness, and said he had been very careful in the statements he had made, believing that it was proper that nothing but the absolute truth should be stated in discussions of that character.

Mr. Pidcock, Borough Surveyor, Northampton, said he had come that day to see the process of dealing with the Coventry sewage, and he was sorry to say he could not pronounce any eulogy upon it. As far as he could see, it was no new system. It was the same principle that he himself had carried out ten years ago, but which he had abandoned: in fact, it had proved so unsatisfactory that they had three injunctions from persons residing upon the river, because of the impurity of the water, and they were driven on to irrigation. He had been surprised that there had been no statistics adduced. That was a most important element in the calculation, and he would have liked to have known what the cost of the shale was. He thought it was scarcely fair to keep facts of that nature back. He had used shale, obtained from Norway, which had cost 5*l.* per ton, and which was, of course, a very heavy charge. Then he had tried different kinds of clay, but these, too, had not yielded the results he desired. But after this system of treatment the sewage really was identical to that used by Dr. Bird, who was the first to suggest the use of sulphates; for in all the other modifications this was the basis. Having remarked again upon the use of various kinds of clay, he said that he had found that the ferruginous clay was best and cheapest. They had been able to send down into the river a clear outflow of effluent water, but it afterwards fermented and produced impurity. He had come to the conclusion that there was no chemical treatment known which would prove successful. He thought that downward filtration, such as had been carried out by Mr. Bailey Denton, at Merthyr Tydfil, might do, but, practically, he believed that the sewage would have to be put over large areas of land, and irrigation was the real solution of the difficulty. Sewage treated chemically would, after having been poured into the river, sooner or later, prove foul.

Mr. Stephens, Borough Engineer of Leicester, said that he too

had been able to produce by chemical process a clear water, but that after it had been in the river a little while it soon became impure. His opinion was that it would have to come upon the land. So he thought that probably the best way would be to combine the two processes, chemical and land.

Mr. PRITCHARD, Borough Engineer of Warwick, argued for the taking into account the utilization of sewage, but he warned town authorities from expecting too great returns. He, too, was in favour of the combination of the two systems, chemical and irrigation; and agreed with the remarks of the President as to the importance of a Commission being appointed by Government to thoroughly investigate the matter, and give them some definite and authoritative information.

Mr. HARPER (Merthyr Tydfil) remarked that this was the first time he had had the pleasure of meeting them, and he was glad to find so much unanimity prevailing. He said he had had considerable experience in dealing with the sewage question, and some years ago he had constructed works at Cheltenham. The General Board of Health of that day had sent down Mr. Austin to investigate the matter, and they had adopted the plan of precipitation and filtration. The tanks had been constructed at great outlay to carry out these two processes, but they had failed. He (Mr. Harper) had constructed the original works at Whitley for this town, seventeen or eighteen years ago, as a contractor. They, too, did not answer. He confessed he had not seen all that he had expected that day. Some time since, at Merthyr Tydfil, they had been visited with injunctions, which had cost the town some seven or eight thousand pounds. A sewerage system had been constructed at a cost of 30,000*l*., and they were now engaged in the construction of works for the treatment of town sewage, which would cost another 60,000*l*. They had purchased 400 acres of land for this purpose. The Court of Chancery had sent down Mr. Bailey Denton to the town, to inspect and report whether something could not be done, while these works were in process of preparation, to mitigate the nuisance which existed. The Rivers Commissioners, in their Report, had made some remarks upon intermittent filtration. Dr. Frankland had said that an acre of land upon this principle would receive and defecate the sewage from a population of 3000. Mr. Denton had recommended the setting apart of 20 acres for the carrying out of the principle of downward filtration. These 20 acres were divided into four parts

of 5 acres each, and each of these parts redivided into eight plots. They were deeply drained to the depth of 7 feet; the land was of a light friable loam character, overlying a stratum of gravel; so that drains need not be nearer together than 60 yards, and though so far apart the land was completely drained. That system was only at work a short time—eight or nine months—and it was not, therefore, long enough time to determine as to what would really be the results, and as to whether the land thus treated would not itself become a nuisance. Referring again to Dr. Frankland's estimate, Mr. Harper gave it as his opinion that an acre of land would not take the sewage from three thousand inhabitants, but that five hundred would be quite as high an estimate as ought to be made. Generally speaking, he expressed himself as decidedly in favour of irrigation.

Mr. Wyles thought it would be fair to ask Mr. Melliss as to what proportion of water was flowing out and over the land that day at the works. There seemed to be an impression among some of the gentlemen who had inspected the sewage works that a large quantity of water was always going off improperly dealt with into the river Sherbourne, whereas he had been told it was only on extraordinary occasions, as on that day, when there was a heavy storm, that any water thus went into the river.

Mr. Melliss said that on occasions like that of the heavy storm of that morning they could not get the whole of the water on to the filter-bed, but that under ordinary circumstances the whole passed through the filter-bed, and therefore went into the river in the condition in which some of them had seen the water issuing from the lower drains that day.

Mr. Pidcock remarked that he thought the use of chemicals would produce a gelatinous substance, which would very soon clog up the filters. He thought three acres would not be sufficient, and would soon get clogged up.

Mr. Melliss said that Dr. Anderson claimed for his process that it was the cheapest, and that the effluent water was good. That day, as they had seen, there had been a great flow of water in a large proportion of mud, which mixed with the water, and which had produced a bad impression upon the minds of those who viewed it. Ordinarily they had not that condition to contend with. As to the cost, he said it would be about 5*l*. per million gallons, chemicals and labour included. He had made that calculation two or three days ago.

Mr. Harper asked if that included the drying?

Mr. Melliss said no.

After some other remarks, a vote of thanks was passed to Mr. Purnell (City Surveyor) for his paper and for his attention to the convenience and comfort of the Members visiting Coventry that day, and Mr. Purnell replied.

The Members then adjourned to the Craven Arms to dinner.

DISTRICT MEETING AT NORTHAMPTON.

The sixth meeting of the District Committee for the Midlands was held in the Council Chamber, at the Town Hall, Northampton, on Thursday, April 15, 1875. Mr. Lewis Angell, C.E., President of the Association, occupied the chair.

The President expressed the pleasure it afforded him to meet the Members of the Association in Northampton. This was the first time they had visited the town, but he had no doubt that there, as elsewhere, they had an interesting day's work carved out for them. He regretted that the attendance was somewhat small, but this was owing to many of the Members being engaged on Parliamentary work then. The critical state of the health of the wife of Mr. Jones, the General Secretary, also prevented that gentleman from attending.

Mr. Pritchard, the Hon. Sec., then read the minutes of the last meeting, which were confirmed. The Secretary also read letters from Members of the Association residing in all parts of the country, expressing regret that engagements which could not possibly be foregone prevented their attendance. They hoped, however, that the meeting would be a successful one.

The President announced that the Council had presented a memorial to the Local Government Board, asking for certain points of amendment in the Local Government Act, especially for that which will put the Borough Engineers on the same level as medical officers, and give them the same protection. No answer to that memorial had as yet been received. They were also preparing one asking for an amendment of the Public Health Acts upon several points suggested by their experience of the working of the old Acts, and which had not been clearly brought before the Government. He found that Mr. Lobley, of Hanley, had summarised a number of points which had occurred to him; they were certainly very valuable suggestions, and he only regretted that Mr. Lobley did not send them through the Association, as they might then have had greater weight with the Local Government Board.

Mr. Lobley replied that it was really a report to the General

Purposes Committee of his Board, and they instructed that it should be printed.

Mr. Monson suggested that an attempt be made to get the words "new road" defined in the new Act, as at present it was a matter of difficulty.

Mr. Pidcock quite agreed with Mr. Monson. Northampton was at that time in a very serious dilemma on account of the difficulty. The Act defined a road to mean a footpath or any public passage, and the consequence was that they had a passage of more than half a mile in length, which, when built upon, made the houses all irregular, being up to the boundary in some places, and 30 feet back in others. He considered there should be a clause compelling those who built by the side of a narrow road to set back, so that there should be at least 20 feet on either side of a mean centre line.

The President remarked that the suggestions made would be considered. With reference to the financial position of the Association, he mentioned that there was 160*l.* in hand, and stated that the Council had decided upon publishing the "Proceedings" of the Society from the commencement.

Mr. Monson objected to the sale of copies to others than Members.

Other Members present considered it would be advisable to adopt the proposal of the Council, believing that the publicity thus given would be of considerable benefit. It was accordingly proposed by Mr. Baylis, seconded by Mr. Purnell, and resolved, that the meeting approve of the publication by Messrs. Spon.

The Members then, under the leadership of Mr. Pidcock, paid a visit to the Sewage Farm. The various matters in progress were explained by Mr. Pidcock, who also replied to the number of questions put by Members of the Association. Returning after a couple of hours' survey, they visited Messrs. Turner Brothers, Hyde, and Co.'s shoe manufactory. The senior partner (Mr. Richard Turner) kindly conducted the party. After this an adjournment was made to the Town Hall, where Mr. Pidcock, of Northampton, read a paper on the Sewage of Northampton.

NORTHAMPTON IRRIGATION FARM.

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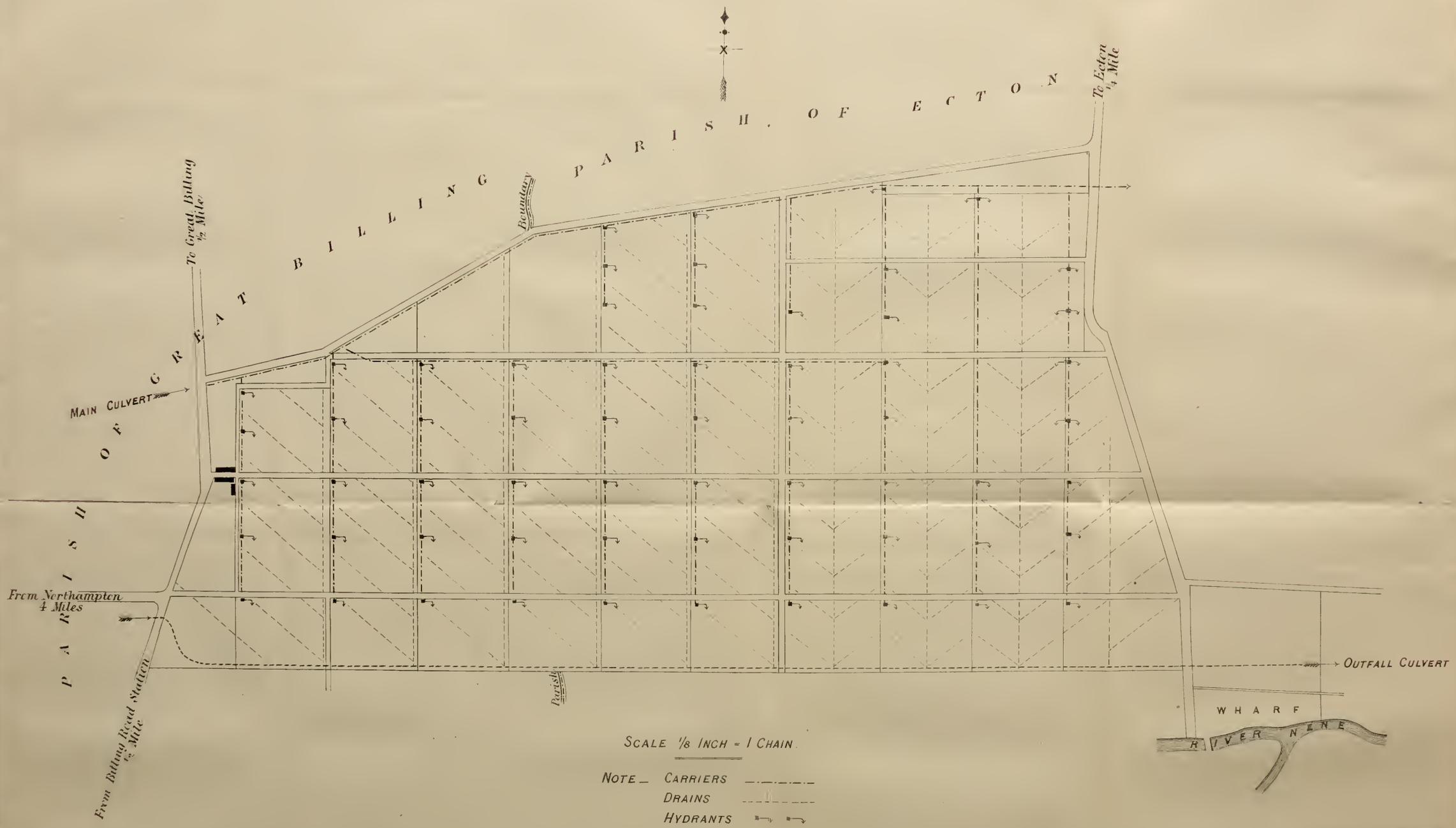

J. H PIDCOCK. Surveyor. 1874.

W. Clowes & Sons 14th H Charing Cross

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NORTHAMPTON AND ITS SEWAGE.

By J. H. PIDCOCK, Borough Surveyor, Northampton.

I propose in this paper to give a slight survey of the advance of sanitary matters in this town during fifty or sixty years, together with some few local statistics, which I hope may prove interesting to you. Northampton is a very old borough, and can exhibit an unbroken line of mayors since 1377. The area of the town is 1520 acres. It is situated on the ironstone series of the lower oolite, on the northern side of a valley through which flows the navigable river Nene, which bounds the town on its west and south sides. The town rises abruptly from the river to an elevation of 120 feet in half a mile, continuing on to tableland on the N.E. to 200 feet in a mile's distance. The town, thus situated, with a S. and S.W. aspect, on a porous soil, ought to be one of the healthiest. The geological formation is very peculiar; the greater portion of the area is occupied by the ironstone, but it is so intermingled with limestone, sandstone, blue and white clays, white sand, yellow sand, and gravel, that frequently in culverting the town, all these have been met with in the length of a single street, the rock and the white clay being so hard as to require blasting with powder. The result of this mingling of strata is a plentiful supply of very pure water, which, in the form of springs, comes to the surface in several parts of the town, but from this natural blessing results much of the sanitary trouble of the town. In olden times every house had its well, generally at a depth of from 6 to 20 feet, and also a necessary in close proximity. Owing, then, to the porous character of the soil, these wells, as the population increased, became contaminated, and were obliged to be disused where very foul, but continued to be used, and are so still where the pollution is not "palpably apparent." Of course, the health of the town suffered, and does so still, from the drinking of this polluted water; but this is a diminishing element, and it is to be hoped that ere long it will be entirely abated, as by the persevering compulsion of water-closet drainage into the sewers, but few of the old middens and cesspits now remain. The government of the town, as regards sanitary matters, has been in

the hands of Improvement Commissioners. An Act of Parliament constituted them such in 1814, another in 1843, and a further one in 1871; but by another Act, passed in 1872 and 1874, the government of the town now resides with the Town Council. The town is supplied with gas and water by private companies, under Acts of Parliament; the latter since 1837; the former about the same time. Gas is supplied to the town at a cost of 4*s.* 9*d.* per 1000 feet, the company being at all costs of erecting, maintaining, and painting the public lamps, of which there are 523. The quantity is calculated on the basis of each burner consuming five cubit feet per hour. The cost of gas to the public is 4*s.* per thousand. The water supply is not in such a satisfactory condition. Water, being a necessity, ought in every case to be in the hands of the authorities, the restrictions on its free use required to ensure success to its commercial proprietors, mitigates against its more liberal use by the public, especially by the poor. The supply is very good in quality, and not excessive in cost, being 1*s.* per thousand by meter to the public. The charge for the use of the town for street watering, &c., being at the rate of 1½*d.* per ton, to be ascertained by meter. I think it should be an object with our Association to press the question of a public supply upon our employers in every town. In early days the turning of house soil into the public shores was visited by a fine. The Act of 1843 gave powers to drain the town and compel house drainage into the culverts; and also to raise 20,000*l.* to effect the work. The money was soon spent, and some drainage works effected; but the want of funds and the indisposition to increase the rates prevented any systematic carrying out of a definite scheme; indeed, so piecemeal was this work executed, that the greater portion had to be removed and deepened to meet the enlarged dimensions of the town. On my appointment to the surveyorship, in 1858, I found matters in a very unsatisfactory state; but few of the streets were culverted; most of the wells of the town had been converted into cesspits; and the soil saturated with ordure. I have seen it oozing through the joints in the rock in making a culvert 20 or 30 yards away from the privies, and at a depth of 12 and 15 feet. Fever and disease were, of course, rampant, the death-rate for 1859 reaching 28·2 per 1000. My first care was to plot a section of all the streets, and lay out a scheme of drainage to meet any future requirements for the whole area of the town; to urge upon the Board the necessity of either procuring more borrowing powers or to increase the rates; to devote them chiefly to the construction of the culverts; to organize a staff of workmen, and to keep

steadily on to the completion. This project was accepted, and has been acted upon since that period to the present. Besides what has been constructed by private owners in new streets, 14¼ miles of culverts have been laid, at a total cost of 17,233*l.*, averaging 13*s.* 9*d.* per yard. The size of each culvert being, the largest, 4 feet by 2 feet 8 inches; and the smallest, 3 feet by 2 feet; the least depth being 9 feet; the greatest, 26 feet. They are constructed in half brick, and the insides rendered in Portland cement. In addition to this a large main culvert has been recently completed in the form of a double 5-foot culvert, 1140 yards long, at a cost of 3405*l.*; 3*l.* per yard. All these costs have included ventilators, at an average distance of 100 yards apart; street gullies, and 9-inch pipe connections, at an average of 60 yards apart; and every expense connected with the complete work. At the same time that these culverts have been in the course of construction, the houses have been made to drain into them, the result being that now, with the exception of a few hundred yards, the whole town is completely sewered, and but very few old middens and cesspits remain to contaminate the water-bearing strata. The effect upon the health of the town since these culverts have been constructed is very palpable and satisfactory. In 1859 the rate of mortality was 28·2 per 1000; in 1860 it was 26·8; in 1861, 24·2; and in 1862, 21·5; so that the effect on the health of the town was immediate in the worst quarters, which were, of course, the first which were taken in hand. This ratio, with one or two exceptional years, when smallpox, through the neglect of vaccination, got a footing, has continued since; but it is to be hoped that this, by the greater control over the habits of the people by the medical officer of health, will be still further reduced. Originally, the sewers emptied themselves into the river, and so, in process of time came up the "pollution of rivers" question. As early as 1855, struck probably with the glowing account of the "El Dorado" at Leicester, Northampton would emulate their enterprise. Mr. Marshall, of Birmingham, was consulted, and devised and carried out some sewage works, consisting of four tanks, 12 feet by 10 feet in area, to filter the sewage through charcoal. I need not note the result. Things went on up to 1860, when larger tanks were constructed, and chemical deodorisers and precipitating agents were experimented upon, but I had to bear the disappointment of seeing all my endeavours succeed no better than others. The agents experimented with comprised separate and combined liquid and solid lime, perchloride of iron, chloride of lime, sulphate of iron, alum, chalk, carbolic acid, and sulphate of alumina; and the filter

beds were prepared with straw, cocoa-nut matting, sand and gravel, ashes, burnt clay, calcined iron ore and chalk, both upward and downward action being tried. The perchloride of iron and the sulphate of alumina were prepared from local materials on the premises, at half the cost they could be otherwise obtained; but all to no purpose. The filtrate still polluted the river, to the satisfaction of no one, I believe, but the Vice-Chancellor, who, in 1868, acceded to the petition of our opponents, and granted an injunction against our works. Another followed in 1870; so, failing all attempts to purify the sewage, an Act of Parliament was obtained to take land for a sewage farm, which it is hoped will put an end to any further trouble on the sewage question, though such immunity has had to be purchased at a price which will for many years keep its memory green.

The Irrigation Farm.—Injunctions having been granted against polluting the river Nene in 1869–70, the town was driven into immediate action to provide a remedy. Two methods presented themselves for adoption. The first, advocated by Messrs. C. Hawkesley, C.E., and Dr. Letheby, was to greatly enlarge the existing works, and precipitate the sewage by means of the crude sulphate of alumina, made from local materials, which had proved itself to be by far the most efficient of anything that had been experimented with. It was composed of the ferruginous loam of the ironstone, digested with sulphuric and hydrochloric acids, in varying proportions according to the character of the loam. The cost of these works would have reached 10,000*l.*, entailing an annual working expense of 3000*l.* I cannot say but that this plan might have succeeded, as the experiments were most hopeful; but taking into account the failure of all the nostrums of the day, and the chemical fact of all the manurial elements of sewage being soluble in water, I could not advise its adoption, but pressed upon the Board the advisability of having recourse to irrigation. This solution was decided upon, and then came the question how to carry it out—by pumping or gravitation? If pumping, the Board had the offer of two estates—one clay, the other sand; each having its summit level 200 feet above the sewage works, and four miles distant. They could only be taken on a short lease, and at a rent of 3*l.* to 4*l.* per acre. The alternative by gravitation necessitated the purchase by compulsory powers of the necessary land; the first that could be reached, by a gradient of 12 inches per mile, being four miles from the town. An Act of Parliament was obtained in 1871 to enable the Board to acquire about 600 acres of this ground, and to raise the necessary

capital. The chief inducement to this decision rested upon a matter of figures. The town being drained on the single system, the amount of sewage requiring treatment would vary from one to six or eight million gallons per day. The engines and mains for such an amount of work were calculated at 40,000*l.*, the working expenses at 2300*l.*, and the rent of land at 4*l.* per acre; thus—40,000*l.*, at 4½ per cent., 1800*l.*; working expenses, 2300*l.*; rent of 327 acres, at 4*l.*, 1308*l.*; total, 5408*l.*

By Gravitation.—80,000*l.*, to be paid off by equal annual payments, in thirty years—4911*l.* 7*s.* 8*d.*, with no working or other expenses, and with no uncertainty as to the continued possession of the land. The estate at the end of the thirty years being the freehold of the town.

The farm, comprising 327 acres, is in form of a frustrum of a cone, 1 mile in length, E. to W., 46 chains deep at the E. end, and 27 chains at the W., with a southern aspect. The fall of the land being pretty uniform, 9 feet N. to S., and 7 feet W. to E. The soil is a rich loam, about 2 to 3 feet deep, on a bed of gravel and quicksand. The whole estate is laid out on a uniform system, being divided by roads, 10 chains apart, running throughout its length; the plot again being equally proportioned, 8 chains in width; thus the majority of the plots are each 8 acres in extent, some 4½ and some 6 acres, the outside plots being a little irregular in quantity. The drainage is accomplished by means of an outfall culvert, 3 feet in diameter, 7 feet deep, running along the base of the land. Nine-inch drains take out of this at every 8 chains; from which again, at every 4 chains, branch diagonal 3-inch drains, from 6 to 5 feet deep, by which means the underlying quicksand has been thoroughly drained. The delivery of the sewerage is effected by means of two 2-foot culverts, running along the northern boundary; from which, at every 8 chains, take down 12-inch socket-pipes to the head of every bed, along which it flows in an open channel (at some future time, as everything becomes established, to be concreted), and so down the plots in the ordinary way. Cast-iron hydrants have been devised, and used for the delivery of the sewage on each plot, so that, with the exception of the open temporary channels, the sewage is never exposed to the air at any part of the farm. The farming operations having up to the present time been only subservient to the engineering work, and on plots as they could be prepared, no statistics can as yet be adduced; but it may be interesting to know the amount of work that has had to

be carried out. Thus has been executed 8½ miles of culvert, varying from 3 feet 6 inches to 2 feet diameter, much of it built in a quicksand; 4 miles of 12-inch glazed socket-piping, 6 miles of hedges grubbed up, 3 acres of plantation stocked up, and 600 timber trees uprooted, 1 mile of iron fencing, 4¾ miles of four-rail fencing, 1¾ mile of quick hedge, 1 mile of parish road diverted; 4 miles of farm roads, 1 mile of flood bank, between 3 and 4 feet high; 120 acres of old pasture land pared, burnt, or destroyed; and about 150,000 cubic yards of earth removed and levelled in; beside stables, cart shed, weighing-machine, &c., and other contingent works. The farm now comprises 200 acres levelled, and will be cropped this year; 19 acres in roads and waste; 56½ acres grass land, which may be levelled; 22½ acres high ground above sewage delivery; 29 acres now in hand levelling; total, 327 acres. The cost up to 31st December, 1874: Parliamentary arbitration, compensation, and law charges, 12,257*l.* 5*s.* 9*d.*; purchase of land, about 130*l.* per acre, 44,960*l.*; works, 20,329*l.* 12*s.* 7*d.*; total, 77,546*l.* 18*s.* 4*d.* The crops in and being sown this year comprise wheat, barley, beans, potatoes, carrots, turnips, mangolds, kohl rabi, broccoli, cabbages, cattle cabbages, rye grass, and osiers. The farm having a railway station within half a mile, and a river wharf on the premises, is well situated for the transmission of produce to distant markets; but my conviction is that the hope of a sewage farm will lie in the keeping of stock, either dairy or growing. The crops are so large, the markets so difficult and distant, and uncertain, except in some few instances, that it appears almost self-evident that the carriage of the produce off the land on animals' backs must be the more remunerative method of working. The area of the borough, 1520 acres; ditto drainage, 500 acres; 1 inch rainfall on ditto, 11½ million gallons; minimum sewage, 1 million gallons; maximum ditto, 6 to 8 million gallons; water supply, about 600,000 gallons; population, about 45,000; the decennial increase of ditto since 1801, 25 per cent.; assessed value, 122,000*l.*; mortgage debts, 92,224*l.*; roads and streets, about 25 miles; number of houses, 9063; annual cost for maintenance of town, repairs, lighting, watering, and scavenging, 7500*l.*

Mr. Pidcock, in reply to questions, said that he could not give the cost per lamp. Instead of putting meters to all the lamps, they took them at 5 feet per hour, and then paid on the hours they were burning. The lamps were lighted by the gas company.

Mr. Pritchard said it was a matter which might be of use to

them, if Mr. Pidcock would inform them as to the velocity of the sewage in the intercepting sewers which had so very little fall, and also whether there was any deposit in the sewer. Much had been said about small gradients, and as this appeared almost an exceptional case, it would be interesting to know Mr. Pidcock's experience with a fall of 12 inches to the mile.

Mr. PIDCOCK regretted that he could not give any reply at present, as the large main culvert was only completed last Saturday.

Mr. SHARMAN asked if he did not get a great deal of the deposit in large tanks?

Mr. PIDCOCK said that was the case. The sludge thus deposited being removed into beds, and these covered with the scavenging of the town, which was sifted, the fine stuff being mixed with the sludge, and the rubbish burnt, its ashes being mixed also with the sludge, and the clinkers got rid of as best they could, for making the foundations of roads, &c.

The PRESIDENT asked if the deposit fetched money?

Mr. PIDCOCK said that he had sold it for 2*s.* 6*d.* per ton, but it had to be reduced to 9*d.* and 6*d.* a ton. They could not get rid of it at a 1*s.*

The PRESIDENT expressed the thanks of the meeting to Mr. Pidcock for the valuable paper he had read, and for his kindness in conducting them over the Sewage Farm. He was exceedingly pleased with what he had seen, and he thought Northampton had commenced and gone on in the right way. He thought Mr. Pidcock's plan of treating the sewage the right one, and he hoped the town gave him credit for what he had done. He agreed with him that the supply of water should be in the hands of the sanitary authorities, or under such Government supervision as would prevent the impure condition of water found in many parts of the country. The health of a town depended upon the purity of the water supplied, and he hoped a deputation would wait upon the Local Government Board asking for a Royal Commission to inquire into the whole question of water supply.

The vote of thanks having been unanimously accorded, Mr. PIDCOCK acknowledged the compliment, and after a few other remarks the proceedings terminated.

The Members afterwards dined together at the George Hotel, the Mayor of Northampton, the Chairman of the Sewage Committee, and other visitors being present.

DISTRICT MEETING AT READING.

The third meeting of the Members of the Home Counties District was held in the Town Hall, Reading, on Friday, May 7, 1875; Mr. Lewis Angell, C.E., President of the Association, in the chair.

After the transaction of some routine business, Mr. Albert W. Parry read a description of the Sewage and Water Works.

THE READING SEWAGE AND WATER WORKS.

By A. W. PARRY, Assoc. Inst. C.E.,
Borough Surveyor, Reading.

Sewage Works.

At one of our meetings last year, when it was known that our new main sewerage works were in progress, a suggestion was made that it would be interesting to the members of the Association to pay a visit to this town, and inspect the works when in full operation. I believed at that time that the whole of the works would have been completed by about the spring of this year, and I naturally presume that the arrangements that have been made by Mr. Ellice-Clark, the Hon. Secretary, for holding the first meeting of the year for the home district in Reading have been based upon that supposition.

The whole of the main sewers and the pumping works and machinery have been completed for some months, but as other works connected with the preparation of the land for irrigation are as yet incomplete, the main sewers cannot be used.

The works were designed, and have been so far executed, by Messrs. Lawson and Mansergh, Civil Engineers, of London, under the inspection of Mr. W. Donaldson, the resident Engineer, and I believe it is not possible or practicable to have had the works, so far as they have been completed, better executed.

Reading is divided into three principal districts by the river

Kennett, and the ridge traversed by the Bath Road. The districts are drained by separate main sewers, which discharge into a 6-feet barrel sewer. The main receiving sewer has been constructed of a large size, in order to act as a reservoir, so that the water power might be used day and night.

Great precautions have been taken to prevent leakage into the sewers, and for this purpose all the brick sewers have been rendered, and are, perfectly water-tight.

Ordinary sewer-pipes have been used, and although very bad leaks occur in one or two instances, in the majority the pipe sewers in wet ground have been laid perfectly tight with cement joints. Many of these pipe sewers are laid 3 or 4 feet under water, and in the Caversham Road in very soft silty foundations. The total leakage in winter is only three gallons per head, and in summer about two gallons. It is expected that a great reduction will be made even in this small amount of leakage when the house drains are connected, as the bulk of the water gets in through the clayed stoppers in the junction-pipes.

The main and branch sewers complete have cost about 49,000*l.*, or 28*s.* per head of population.

Duplicate engine power has been provided at the pumping station, because during a part of the year the Thames floods render the water-pumping power useless. To provide for the possible contingency of a break-down of all three, or a rupture in the rising main, an overflow into the river has been provided.

There are two horizontal condensing-engines, with 24-inch cylinders, and 3 feet 6 inch stroke, with three boilers, 28 feet long and 5 feet diameter. The engine-pumps are 2 feet 6 inches diameter aud 3 feet stroke, working at the rate of 15 strokes per minute. There are three turbines for ordinary pumping purposes, and one additional for supplementary power.

The turbine pumps are 18 inches diameter, and 2 feet 6 inches stroke, which work 15½ strokes per minute.

The cost of these works have been as under:

Sluices and buildings	£14,700
Engines, boilers, and pumps	6,500
Turbines	1,800
Total	£23,000

All these and other details, as well as the plan showing the system on which the main sewers have been laid and ventilated, will be seen when we reach the pumping station.

In accordance with the advice of the engineers, and Mr. J. T. Blackburn, who is their special professional adviser on matters connected with the irrigation farm, the sanitary authority have adopted a novel plan for the profitable utilization of their sewage. Hitherto it has been supposed that nearly every acre of a sewage farm ought to be irrigated, and not farmed in connection with other lands. The sanitary authority, warned by previous failures, have determined so to arrange their farms that the irrigated portion shall be looked upon not as a farm in itself, but as an adjunct to a farm. For this purpose about 700 acres of land have been purchased admirably suited for the object.

The lands purchased lie to the south-west of the town, and consist of high irrigable land on the east and west, with a belt of meadow land between, which is at present flooded but will be laid high and dry, except during unusually excessive floods, by the works now being executed for the improvement of the Kennett. By the lowering of the Kennett above the town, the sanitary authority will not only improve the meadow land they have purchased, but will acquire a very valuable addition to their water-works pumping power at Fobney Lock.

The land will probably be ultimately laid out in three farms; only one has as yet been commenced, and is still in such an embryo state of preparation, that a visit to it would be of little use.

Waterworks.

The waterworks, as compared with the main sewage works, take rather a different character, being not new and incomplete, but old and incomplete; and before very long it will be necessary to improve the means of supply by availing ourselves of the recently acquired additional water power at Fobney Lock as a substitute for our present expensive auxiliary, steam pumping, and of providing additional filtering area.

The supply of water to the town is obtained by pumping from the river Kennett at Southcot, a distance of about a mile and a quarter south-west of the receiving or settling reservoirs at Bath Road.

The pumping machinery at Southcot consists of two water-wheels, 15½ feet in diameter and 8½ feet wide, with a fall of water of about 6 feet.

These wheels drive two sets of three through single-acting lift-

pumps, with plungers 12 inches in diameter and 3 feet stroke, at a speed throughout the year at an average of about 10 strokes per minute.

A third similar set of three pumps is driven by a portable engine of 25 horse-power. The wheels are constantly at work during the twenty-four hours, and the engine-pumps, during the last three years, have been worked about 160 days each year as required. The water is pumped up two 12-inch mains to the Bath Road works, a height of about 82 feet.

At the Bath Road are two settling reservoirs containing about 4,710,000 gallons of available water, and three circular filters 50 feet in diameter each.

The filters receive the entire head of water from the reservoirs above the filtering material, which is about 5 feet deep, resting upon a slate bed, through the open joints of which the water passes into a chamber below, about 18 inches deep; and is conducted from each chamber, by means of a 12-inch pipe, to a filtered water well from which the town receives its supply.

The high-level parts of the town are supplied by means of two elevated tanks; one at the Bath Road works and the other at Whitley. The water is pumped from the filtered water well into these tanks by means of two 8 horse-power vertical engines, each of which works by a lengthened piston, a pump with $6\frac{3}{8}$-inch plunger, at a rate of about 50 strokes per minute.

The Bath Road elevated tank contains about 119,000 gallons of water, which supplies about 1660 inhabitants; the pump working from eight to twelve hours per day.

The Whitley tank contains about 114,000 gallons, and supplies about 2600 inhabitants; the pump working about sixteen hours per day.

At Mill Lane there are two sets of three-plunger pumps, 9 inches diameter, with a 21-inch stroke, which until lately could be worked by water-wheel power, the fall being about 5 feet; this water power is now destroyed, and the only available power for working these pumps, which are usually used one set at once, is by means of an 8 horse-power beam-engine; the water is pumped directly from the river into a reservoir at Spring Gardens, a height of about 90 feet, which contains about 710,000 gallons. This water is not filtered; and has been used for supplying the Great Western Railway works and for watering the roads.

As long as the water power at these works was available, the

pumps were worked for about ten hours per day: but since then, to save the expense of steam pumping, the unfiltered water mains have been fed from the Bath Road works, and the water in the Spring Gardens reservoir has not been used, and, together with the steam power at Mill Lane, will be kept in reserve until the requirements of a coming summer and probable dry season may require it.

It will occur to many, after the description I have given, that the pumping power at Southcot is considerably in excess of the filtering area provided in the Bath Road works. This is so, and has originated in this manner.

The water-works at Southcot and Bath Road were originally designed and executed about twenty-five years ago, for the purpose of supplying the town, when it contained a very much smaller number of inhabitants than it contains at the present time. There were at that time at Southcot only the wheel pumps. About seven years ago it was found necessary to provide for an increased supply; and it was then that the third set of pumps and the second 12-inch pumping-main were put down, and the portable engine stationed there as an auxiliary, to be used when required in dry seasons; but no provision was made to filter the additional quantity of water; and the whole of the water received at Bath Road has to pass through these filters.

It is fortunate that the water taken from the river at Southcot is of good quality, which is seen from recent analysis made by Dr. Shea, our medical officer of health, which I have given as follows:

WATER ANALYSIS, READING COMPANY WATER.

Sample taken from filter in the Bath Road:	In grains per gallon.
Total solid residue	19·95
Total volatisable	2·45
Hardness	14°
Ammonia, free	0·0007
Ammonia, albuminoid	0·0045
Nitrogen as nitrates	0·235
Chlorine as chlorides	0·950

The sample was clear; no offensive smell emitted on boiling with alkali.
Residue scarcely darkened upon ignition.
No living organisms visible under microscopic examination.

June 27, 1873. (Signed) JNO. SHEA, M.D., B.A.

In a second sample from the town mains a few small fresh water crustaceans of the "cyclops" class existed. These are simply very small fresh water shell-fish.

It will also appear that a large quantity of water is supplied to

the town, considering the population, which may be taken at 35,000 inhabitants. There are a greater number than that in the district supplied, which includes a district beyond the borough; but many houses in the town are supplied by pumps, which may balance the excess of population given.

The head of water in the river during the last four months has been at its maximum, and the wheels and pumps are capable of working at their highest speed, which has been from 11 to 12 strokes per minute, and the supply to the town has been maintained mainly by the wheels alone, which, although their theoretical capacity would give 1,231,200 gallons per day, practically raise about one million gallons per day, or 28½ gallons per head of population, and which, up to the present time, has also included the supply for street watering, and a portion of the supply to the Great Western Railway.

This quantity in a residential town, as Reading really is, and where the number of business establishments requiring a large supply of water is small, is much in excess of what it ought to be; and we have recently instituted a system of efficient inspection of waste of water, by which means, and the substitution of good fittings for the many imperfect ones now existing, the quantity of water taken by consumers will, I have reason to believe, be greatly reduced.

The Mayor (Mr. C. Smith) said, he should like to supplement Mr. Parry's paper with a few remarks. In carrying out the works, the separate system of drainage had been adopted, the surface and storm water being kept entirely separate from the sewage, the new sewers and drains being used for sewage only, and the old drains for carrying off the surface water. In towns where there were tidal rivers into which the authorities were allowed to drain, there was no objection to draining both the sewage and surface water into the sewers, but in Reading, where there would be a system of irrigation, it would be extremely unwise to reduce the quality of the sewage by dilution with the surface water. Unusual difficulties presented themselves when the sewers were being laid; several miles of sewers had to be laid under the water level, and in consequence of the head of water that showed itself, pumping for several months had to be resorted to. The plan adopted in the construction of the brick sewers had been a great success, and, practically, there are no leaks in these sewers. The brick sewers under water had been formed with two rings of brickwork with two renderings in cement, the

whole being finished with cement concrete. Any leakage that there had been had occurred in the pipe drains, and through the eyes left for future house connections. The lowering of the river Kennett for the better drainage of the farm lands gave them all improved fall of water at Fobney Lock, which they would be able to utilize for pumping purposes in the extension of their water-works, and so do away with the necessity of steam pumping.

The Members then made an inspection of the sewers outfall and the waterworks, and upon their return a paper was read by Mr. Ellice-Clark "On the Average Meter System for Determining the Consumption of Gas in Public Street-lamps."

ON THE AVERAGE METER SYSTEM FOR DETERMINING THE CONSUMPTION OF GAS IN PUBLIC STREET-LAMPS.

By E. B. ELLICE-CLARK, Assoc. Inst. C.E.,
Town Surveyor, Ramsgate.

The subject of this paper is by no means a new one, nor, I fear, am I able to point out many fresh features to those who are already acquainted with it. My desire to read a paper on the subject is to assist those Surveyors who continue to burn the gas in the public lamps without regulators or meters, and to inquire as to the cause of failure of the average meter system in those towns where it has been tried and discontinued; and, by pointing out the advantages of adopting it, to put an end to one of the points of dispute which exist in nearly all towns where the gas is supplied by a company.

The town of Ramsgate contains about 17,000 inhabitants, and is lighted by 244 lamps. Up to June, 1873, the price for permanent lamps was 3*l.* 10*s.*, and for non-permanent (not lighted on moonlight nights), 3*l.* 1*s.* per annum; this arrangement the company declined to continue, and gave notice of charging 5*l.* for permanent, and 4*l.* 15*s.* for non-permanent lamps. The board considering this enormous increase unwarranted by the price of coal, I communicated with various other towns as to the manner and cost of lighting, and as they will be of value to others gaining information, I have tabulated them in the Appendix, No. 1. It will be seen from the answers, that out of eighteen towns coals averaged 35*s.* 4*d.* per ton, and gas was charged 4*s.* 11*d.* per 1000 to private consumers; the highest price was paid by Bromley, where the price per lamp was 5*l.* 3*s.* 6*d.*, with coals at 40*s.* per ton, and the lowest at Lowestoft, where the lamps were charged for 2*l.* 17*s.* each, and coals at 35*s.* per ton. This wide difference in the price of gas and coal is to be accounted for by the fact that the lamps at Lowestoft only burn 1300 hours per annum. It was then determined to try experiments to test the practicability of burning petroleum for street lighting, and I had one street fitted up with lamps for this purpose. The lamps were ordinary ones with inch burners, and

vessel to contain a quart of oil, from the 11th to the 31st of December (20 days), the maximum force of the wind being 7, and the minimum 1. The lamps averaged 23 pints of oil consumed in 276 hours 46 minutes; or, 1·10 pint per night of 13 hours 12 minutes. This gives a cost of 2*d.* for 12 hours; the cost of gas at 5*s.* per 1000 would be a fraction less than 3½*d.* for the same time. To the price of the oil was added the cost of lighting, cleaning, and the supply of wicks; this I found to come to 75 per cent. on the cost of the oil, bringing the cost to 3½*d.* for 12 hours, being more than the cost of gas for the same time.

So far as the light was concerned, by a photometric test, it was found to be equal to that of gas of 13 candles.

The important and bad features of lighting by oil are: a large shadow is thrown across the road that cannot be avoided; the difficulty of lighting in wet and windy weather is so great as to entirely preclude its use, and the danger likely to occur from the receivers or chimneys being broken, the lamp becoming at once extinguished. These led me to conclude that oil for the purpose of lighting our streets was impracticable. I then reported on the use of the average meter indication as being a fair and equitable mode of determining the cost of street lighting, which had now reached 1140*l.* per annum for 240 lamps. I found that they burnt 8 hours 40 minutes per diem, or 3163 hours 25 minutes per annum. Burning 5 feet of gas per hour, they would consume 15,817 feet per annum; at 4*s.* 6*d.* per 1000 feet this would cost 3*l.* 11*s.* 2*d.* per lamp; to this should be added the cleaning, lighting, and repairing, which I considered should cost 10*s.* per annum, reducing the cost of lighting to 974*l.* per annum, but I thought a still further reduction could be made.

1. By a redistribution of the lamps.
2. By having governors to burn 4 feet per hour.

We then advertised for meters, and, after careful consideration, selected those of Messrs. Alexander Wright and Co., of Westminster, at a cost of 6*l.* 10*s.* each, and 2*s.* 9½*d.* each for the governors, and entered into a contract for the testing and regulation of the governors at 7*l.* per annum.

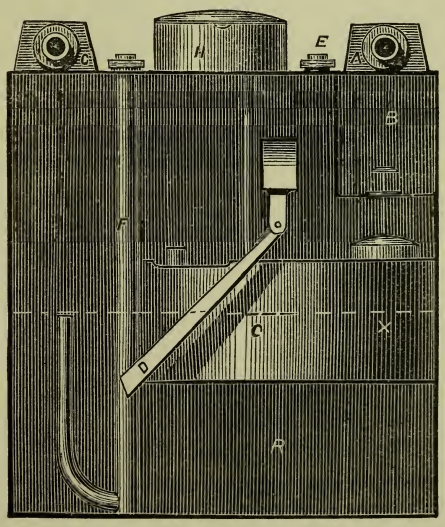
A wet meter was chosen in preference to a dry one, as not being so likely to get out of repair by the vibration of the valves caused by the street traffic, which would be sure to cause escape.

The average meter system could not be carried out without the quantity of gas consumed in each lamp being quite under control.

It must be obvious, if this were not the case, that the determining the consumption of only a certain number of lamps would be of no value, and whether the meter system or not is adopted, it is very necessary both for the companies and ratepayers that the gas consumed should be the same in every lamp; for it has been found, on applying test-meters to different lamps, that while some lamps have burnt as much as 11 feet, others have been consuming only 3 feet per hour.

The governor or regulator is dry, and has a leather diaphragm with a suspended cone which governs the aperture that admits the gas to the under side of the diaphragm, and is so weighted on the top side as to allow any pressure desirable. In our case they are adjusted to consume 4 feet per hour. The burner is an ordinary bat's-wing, screwed to the upper side of the governor, and placed somewhat higher than the ordinary tap burner, so that the diaphragm shall not be injured, and, further, to obtain an even flow of gas and give a steady flame. Previous to fixing, each governor should be thoroughly tested by the minute clock; then, say, six of them may be fixed and lighted, and if adjusted to 4 feet, should

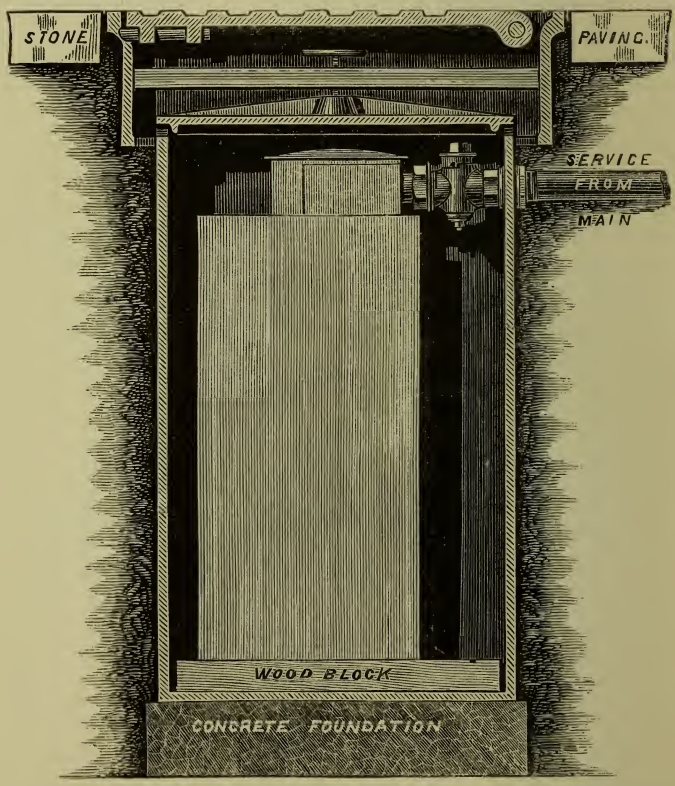
FIG. 1.



collectively consume 24 feet in the hour This testing of the governors should take place at least once in each year, having a spare number to fit on the lamps while this operation is being performed, taking, say, 8 per cent. of the total in each month.

Fig. 1. A, inlet of meter; B, box with valve-seat and valve-cover, the latter carried on a rod attached to a float in C, the water-level cistern; D, compensating scoop, which, when the meter is in action, lifts small quantities of water from the reservoir, R, and delivers the same into the cistern C so as to maintain the water at the proper height, within the measuring chambers of the meter, any excess of water delivered into C flowing back into R; E, socket on the top of a pipe descending into the meter, through which the meter is charged with water; F, suction-pipe for the insertion of the tube of a small pump or syringe, whereby to remove any excess

Fig. 2.



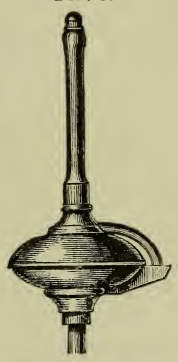
of water from the meter, and from the reservoir to the dotted line X; G, outlet of meter; H, index.

Fig. 2 shows the cast-iron box in section, with the side elevation of the meter and inlet-cock. The inner lid of the box is screwed down to its seating, and the junctions made water-tight with an indiarubber washer. The external lid is roughened, and is fitted with a lock.

Fig. 3 is the governor.

It has been suggested that methylated spirits should be used as a protecting medium against the attack of frost; but a little consideration will show that such a substance would be an active conductor of caloric from the water in the meter by convection. The expansion of water, and its ascent to the surface just previous to, and the giving forth of a certain proportion of latent heat at, the moment of congelation, prevents the sea and adjacent land from being reduced to a temperature inconceivably cold, which would clearly be the result were the atoms of water to follow the rule of those of other fluids, including methylated spirits, of becoming dense in proportion to their loss of heat. I can think of no better protector against frost than a stuffing of cowhair or wool to entangle a large quantity of atmospheric air, which is almost a perfect non-conductor of heat where the currents constantly being generated within it are retarded.

Fig. 3.



The number of meters should, in my opinion, be not less than one to twenty lamps. We have one to every twelve lamps. Care should be taken as to what lamps the meters are fixed, and that an average level be obtained by the sum of the heights of the metered lamps, also as to the main on which the meter is fixed. For instance, on turning to the tabulated statement, lamp No. 240 has only consumed 4400 feet in 1029 hours, whereas 5 feet an hour would give a consumption of 5145 feet. This lamp is the last on a small main, and therefore the pressure of gas is not very great. In determining which lamps should be metered, it would be well to choose a certain number on small, intermediate, and large mains, so that there will be a fair average pressure on the whole of the meters. On the first working of the system it would be well to take the consumption every week, so that escapes or other defects could be rectified. The indications should be entered in a specially ruled book, somewhat as follows:

METERAGE OF STREET LAMPS.

Date.	No. of Lamp.	Index of Meter.	Consumption.	No. of Hours Lighted.	Average per Hour.	Remarks.

The indications taken between the quarters are mere checks, and do not determine the total consumption, which is ascertained by simply taking the difference between the readings on the first and last day in the quarter, and multiplying it by the number of lamps. To determine the average consumption per hour, this must be divided by the sum of the hours each lamp burns. A table, showing the time of lighting and extinguishing the lamps each day, and the number of hours lighted, with totals every fortnight, should form part of the contract between the company and the lighting authority, and it will render easy the checking of the consumption if from any cause this is found necessary.*

The readings of eight of the meter lamps at Ramsgate, taken at different periods for the quarter ending March 31, 1875, when regulators of Messrs. Wright and Co.'s manufacture, adjusted to consume 5 cubic feet of gas per hour were employed, which regulators have since been changed for others adjusted to consume 4 cubic feet of gas per hour each, were as follows:

READINGS OF METERS FOR QUARTER ENDING MARCH 31, 1875.

No. of Lamp.	Locality.	Level above Ordnance Datum.	Consumption in Cubic Feet per Hour.			Remarks.
			Jan. 1 to 15.	Jan. 15 to 28.	Jan. 28 to April 1.	
135	High Street ..	64·00	4·5	5·2	4·8	Minimum reading of thermometer during this period, 23·5. Freezing hard for three days.
2	Sussex Street ..	65·00	5·3	4·8	5·9	
153	Boundary, King Street	51·00	5·2	4·9	4·9	
231	Victoria Road ..	109·00	5·2	4·5	5·05	
66	Hertford Street	61·00	5·0	5·0	5·9	
240	West Parade ..	83·40	5·2	3·7	4·70	
225	South - Eastern Road	107·00	5·8	5·3	4·9	
32	York Street ..	17·80	5·3	5·0	5·05	
	Total ..	558·20	41·5	38·4	41·20	
	Average ..	69·76	5·19	4·8	5·15	

* See Appendix, No. 2.

The total consumption for the quarter was as follows:

Index. Jan. 1, 1875.	Index. March 31, 1875.	Consumption.	No. of Lamp.	Level of Lamp.
Zero	5,200	5,200	135	
800	5,900	5,100	2	
600	5,700	5,100	153	
800	5,800	5,000	231	
600	5,800	5,200	66	
100	4,500	4,400	240	
800	6,500	5,700	225	
Zero	5,200	5,200	32	
		40,900 ÷ 8 = 5112 cub. ft. each lamp.		

Cubic Feet.		Lamps.		Cubic Feet.		Meter.		Total Consumption.
40,900	×	244	=	9,979,600	÷	8	=	1,247,450

Cubic Feet.		Hours.		Cubic Feet.		Lamps.		Average per Hour.
1,247,450	÷	1,029	=	1,212	÷	244	=	4·97

Each lamp has burned as nearly as possible 5 feet per hour.

1,247,450 cubic feet at 4*s.* 6*d.* equal	£280	17	6
Less 10 per cent.	28	1	9
	£252	15	9
10,430 at 4*s.* 6*d.*, less 10 per cent., burned by new lamps	2	2	6
	£254	18	3
248 lamps at 17*s.* 6*d.* per annum rent and cleaning ..	54	5	0
Amount of quarter's lighting	£309	3	3

It will be seen that the total consumption, as registered, was as nearly as possible what should have passed through the 5-feet regulators, the consumption being 40,900 against 41,160, the quantity that should have been consumed if each lamp had duly burnt 5 feet an hour.

In drawing up the conditions with the company supplying the gas, it will be necessary to insert, amongst the other clauses, the following, which I believe were taken principally from the committee's report to the Paddington Vestry:

The gas shall be measured by a meter to be attached to one lamp in every twelve lamps, and the average consumption of the whole of the lamps to which meters are attached shall be taken to represent the average consumption of each lamp supplied.

The particular lamps to which the meters are to be attached shall

be agreed upon between the surveyor to the local board and the manager to the gas company for the time being.

The meters shall be wet meters of the best and most approved construction, and made by makers of acknowledged reputation, and shall be tested and approved by the company.

The meters shall work when new with such friction that the excess of pressure on the inlet over that on the outlet shall not exceed $\frac{1}{10}$th of an inch of water.

Each meter shall be placed in an iron box of suitable construction, made water-tight by proper lids, to be let into the ground near the foot of the lamp-column.

Each lamp shall be furnished with a proper burner and governor of the best construction, and the burners and governors shall be precisely similar in all the lamps, metered and unmetered. Each burner shall be so constructed as to burn not less than 4 cubic feet of gas per hour, with the pressure hereinafter mentioned at the point of issue. The governor shall be so adjusted as to maintain this pressure certainly, and uniformly under the usual variation of pressure in the mains.

The pressure at the point of issue in the burners shall be fixed at $\frac{5}{10}$ths of an inch of water.

At intervals not exceeding one year every meter shall be taken out, examined, cleaned, and tested as regards its friction, and put in order if necessary. Testings may also be made for the friction *in situ* (by proper apparatus contrived for the purpose) at more frequent intervals, at the option and at the expense of the company. If at any time the friction of the meter shall be found to exceed 0·15 inch of water, the meter shall be at once taken out and readjusted, so as to reduce the friction to the normal amount of $\frac{1}{10}$th of an inch.

Every governor shall be taken down and retested, and if necessary readjusted and put thoroughly in order, at least once a year.

The register of each meter shall be read and recorded at regular intervals by two officers going round together, one to be appointed by and on behalf of the company, and the other to be appointed by and on behalf of the local board, and their joint record (or the record of one of them if the other should fail to attend at the hour to be from time to time appointed and agreed upon by them in writing for the purpose) shall determine the date from which the average consumption is to be calculated. This record shall be taken fortnightly, commencing on the day of

next, or at such other times as may be agreed upon between the parties.

If on any official reading the record of any meter shall vary more than 20 per cent. from the quantity that ought to be consumed, the record of that meter shall be omitted in taking the average, and the whole apparatus connected with that lamp shall be at once thoroughly examined in order to detect and rectify what is wrong.

In those towns where the system has been tried and abandoned, Mr. Charles Hawksley considers the reasons of failure to be—

1. The employment of too small a meter.
2. The use of dry meters.
3. The want of governors.
4. The attempted adjustment of the consumption by means of the double tap.

To these may be added—5, accepting a cheap and badly constructed meter; 6, the improper fixing of the meters to the lamp services; 7, the want of care in choosing the site of the meter-lamps as to levels, size of service-pipe, &c.; and 8, to the wet meters being improperly protected during the presence of frost.

All of these objections can be surmounted with little difficulty and ordinary care; and, wherever the system is adopted under the conditions I have spoken of, I am sure it will be satisfactory both to the companies and the ratepayers.

In conclusion, I have to express my thanks to Mr. W. A. Valon, C.E., the manager of the Isle of Thanet Gas Company, for the trouble he has taken in making this system a success in Ramsgate.

APPENDIX No. 1.

Replies from Towns, January, 1874.

Town.	Do the Works belong to a Town or Company?	Do your Board pay per Lamp per Annum, and how much?	Have you ever paid by Average Meter Indication?	Do the Posts, Standards, Lanterns, &c., belong to your Board or the Company?	What has been the average Price of Coal per Ton in your Town the last year?	Is the Gas supplied obliged to be up to a Standard of Illuminating Power; if so, what?	What is the present Price per 1000 Feet to Private Consumers?	Has the Price been raised within Two Years past? if so, how much.	What is the Number of Public Lamps per mile of Street?	Can you give me any other information as to Street Lighting in your Town?
Ashton-under-Lyne	To a company.	So much per 1000; 3*s.* 6*d.*	No.	To corporation.	..	Yes; 22 sperm candles.	4*s.* 6*d.*	6*d.* per 1000.	About every 65 yards.	We do not use ladders, but light by a kind of lantern at the end of a staff.
Acton	Brentford Gas Company.	4*l.* 15*s.*	No.	Company.	There are several sorts, varying from 32*s.* to 50*s.*	It ought to be 12 candles.	4*s.* 6*d.*	No.	Irregular.	No.
Bromley ..	Bromley Gas Consumers Company Limited.	5*l.* 3*s.* 6*d.*	No.	Company.	40*s.*	Not fixed.	5*s.*	5*d.* per 1000.	Twenty.	
Chichester ..	Company.	4*l.* 10*s.*	No.	Company.	36*s.* to 40*s.*	Equal to 14 candles.	5*s.*	No.	155 lamps in the city.	No.
Chatham ..	Company.	3*l.*	No.	Board.	Furnace coal, about 30*s.*	Ten candles; burns about 5 feet per hour.	3*s.* 6*d.*	No.	About 50 yards apart.	Company very rich; and attention required, it is done immediately.
Chelmsford ..	Company.	3*l.* 15*s.*	No.	Board.	About 35*s.*	No.	5*s.* 6*d.*	Yes; 6*d.* per 1000.		
Colchester ..	Company.	3*l.*	No.	Board, and repaid by Company.	30*s.*	14 candles.	4*s.* 3*d.*	No.	About 76 or 80.	No.
Eastbourne ..	Company.	Last few years, 3*l.* 10*s.* 6*d.*; this year, 5*l.*	No.	Board.	40*s.*	14 candles.	5*s.*	No.	About 60.	Repairs, painting &c., cost 5*s.* 6*d.* per lamp in addition to above.
Ealing	Company.	4*l.* 10*s.*	No.	Board.	37*s.*	..	4*s.* 6*d.*	Yes; 3*d.* per 1000, lately.		
Falmouth ..	Company.	No.	Yes, worked by that system.	Board.	33*s.*	No.	6*s.* 8*d.*, with a discount of 10 per cent.	Yes; 1*s.* 3*d.* per 1000 ft. 1st yr., 6*d.*; 2nd yr., 9*d.*	Ninety.	
Gravesend ..	Company.	2*l.* 19*s.* 6*d.*	No.	Board.	Company paying 20*s.* per ton at pit's mouth.	Yes.	5*s.*	Yes; 1*s.* per 1000.	Average, about 25.	

Ipswich ..	Company.	2*l.* 18*s.*	No.	Company.	From 26*s.* to 36*s.*	14 candles.	4*s.* 6*d.*	From 3*s.* 9*d.* per 1000.	50 yards apart.	
Kingston-on-Thames ..	Company.	5*l.*	No.	Board.	31*s.* 6*d.*	Kept over 14 candles.	5*s.* 6*d.*	1*s.* per 1000.	Forty.	
Lymington ..	Company.	5*s.* 6*d.* per 1000 cubic feet, and 15*s.* per annum per lamp for cleaning, repairing, and lighting.	Yes.	Board.	35*s.*	13 candles.	7*s.* 6*d.*	1*s.* per 1000.	Every 50 yds., on both sides of the road.	No.
Lowestoft ..	Company.	2*l.* 17*s.* per lamp for 1300 hours, at 5 feet per hour, and 6*s.* per 1000 feet on all consumed in excess of the above.	No. We use Sugg's 5-feet governors, and are converting them into 4-feet governors.	Company who charge at the rate of 18*s.* rent per post per annum. This includes lighting, &c., and is included in the 2*l.* 17*s.*	35*s.*	No.	6*s.*	1*s.* per 1000.	Average, 75 yards apart.	
Leamington ..	Company.	No.	Meter to every 12 lamps, and pay for the gas consumed.	Board.	House, 30*s.*; rough slack, 20*s.*; fine ditto, 15*s.*	Not less than 14 candles.	4*s.*	About a year ago reduced to 3*s.* 9*d.*, but now at old price — viz. 4*s.* per 1000.	40 lamps per mile.	Months of June, July, and August every other lamp only is lighted; months of Nov., Dec., Jan., and Feb., the whole lighted; the other five months there are seven nights of alternate lighting, while the moon is nearly full.
Maidstone ..	Company.	4*l.* 1*s.* 6*d.*, including repairs, &c.	That was how present average price was arrived at.	Board.	40*s.*	14 candles.	4*s.* 3*d.*	Yes; I think 6*d.* per 1000.	Cannot say.	About 60 yds. apart, but not always adhered to.
Folkestone*..	Company.	No.	Yes; 1 meter to every 12 lamps.	Posts, &c., to corporation; the regulators to the company.	36*s.*	Yes; a burner consuming 5 feet per hour is equal to 14 sperm candles, each burning 120 grains.	5*s.*	Yes; 9*d.* per 1000.	Not more than 50 yds. apart. There are 330 lamps, which is equal to one to every forty inhabitants.	

* The average meter indicator system has been in operation the last five years, and found to act well. Sugg's self-acting regulator is used, adjusted as nearly as may be practicable to consume 4 feet per hour, and so very satisfactory is this apparatus, that for the last two years, after burning 7294 hours, it is found by the average meter to have consumed 29,227 feet, as against 29,176 feet as per regulator, being only 51 feet in excess of that which the apparatus is adjusted to consume. The whole of the lamps are lighted every night during the year, but the corporation are at liberty to discontinue the lighting on such day or days, not exceeding seven days in every lunar month, by giving to the manager of the company not less than 24 hours' previous notice in writing. The repairing of the glass to the lamps is let to contract; this year the price is 1*s.* per lamp, 21 of glass being used. The corporation light, extinguish, and clean the lamps, employing five men for the purpose, three at 7*s.* and one at 5*s.* (to light and extinguish), and one at 17*s.* per week, who light, extinguish, and clean the lamps. The present price of gas to the corporation is 4*s.* 6*d.* per 1000 feet, which is the maximum price allowed by the company's Act. I enclose a set of cards showing the time of lighting and extinguishing the lamps.

APPENDIX No. 2.

TIME OF LIGHTING AND EXTINGUISHING LAMPS, AND HOURS BURNING.

Date.	Commence Lighting.	Commence Extinguishing.	No. of Hours Burning.	Total.
January 1	3·55	5·30	13·35	
2	3·55	5·30	13·35	
3	3·55	5·30	13·35	
4	3·55	5·30	13·35	
5	3·55	5·30	13·35	
,, 6	3·59	5·26	13·27	
,, 7	3·59	5·26	13·27	
,, 8	3·59	5·26	13·27	
,, 9	3·59	5·26	13·27	
,, 10	3·59	5·26	13·27	
,, 11	4·3	5·22	13·19	
,, 12	4·3	5·22	13·19	
,, 13	4·3	5·22	13·19	
,, 14	4·3	5·22	13·19	
,, 15	4·3	5·22	13·9	201·45

And so on each day.

SUMMARY FOR YEAR.

Date.	No. of Hours per Month.	No. of Hours per Quarter.
January	407·25	
February	326·42	
March	294·53	1029·0
April	225·25	
May	186·28	
June	146·29	558·22
July	164·4	
August	209·6	
September	261·32	634·42
October	330·22	
November	382·24	
December	428·35	1141·21
Total	..	3363·25

Note.—Since writing the above I have found several of the meter lamps extinguished without apparent reason; after careful investigation I found that a quantity of water was formed in the lamp column from condensation, and, dropping into the meter, extinguished the flame. To obviate this I had a small chamber inserted in the outlet-pipe of the meter at the base of the lamp, consisting merely of a piece of gas pipe 3 inches deep, to receive the water thus formed, and prevent its going into the meter; this receiver is emptied with a syringe when the indexes are taken, and is covered with a small sheet box—and has thoroughly answered the desired end. E. B. E.-C.

TIME TABLE FOR LIGHTING AND EXTINGUISHING PUBLIC LAMPS IN THE BOROUGH OF PORTSMOUTH.

ARRANGED BY L. ANGELL.

Price per lamp, 4*l.* 5*s.*, including lighting (all the year round), cleaning, and repairs.

Week ending	Commence to Light at	All to be Lighted by	Commence Extinguishing at	All to be Extinguished by
	P.M.	P.M.	A.M.	A.M.
January 8	3 30	5 0	7 5	8 25
„ 15	3 35	5 5	7 5	8 25
„ 22	3 45	5 15	7 0	8 20
„ 29	4 0	5 30	6 40	8 0
February 5	4 10	5 40	6 30	7 50
„ 12	4 25	5 55	6 25	7 45
„ 19	4 35	6 5	6 20	7 40
„ 26	4 50	6 20	6 0	7 20
March 5	5 5	6 35	5 50	7 10
„ 12	5 15	6 45	5 30	6 50
„ 17	5 30	7 0	5 30	6 50
„ 26	5 40	7 10	5 0	6 20
April 2	5 55	7 25	4 45	6 5
„ 9	6 5	7 35	4 30	5 50
„ 16	6 15	7 45	4 20	5 40
„ 23	6 25	7 55	4 5	5 25
„ 30	6 35	8 5	3 45	5 5
May 7	6 50	8 20	3 30	4 50
„ 14	7 0	8 30	3 20	4 40
„ 21	7 10	8 40	3 10	4 30
„ 28	7 20	8 50	3 0	4 20
June 4	7 30	9 0	2 50	4 10
„ 11	7 35	9 5	2 45	4 5
„ 18	7 45	9 15	2 30	3 50
„ 25	7 45	9 15	2 30	3 50
July 2	7 45	9 15	2 30	3 50
„ 9	7 35	9 5	2 45	4 5
„ 16	7 29	8 59	2 55	4 15
„ 23	7 21	8 51	3 0	4 20
„ 30	7 10	8 40	3 10	4 30
August 6	6 59	8 29	3 20	4 40
„ 13	6 46	8 16	3 30	4 50
„ 20	6 32	8 2	3 40	5 0
„ 27	6 18	7 45	3 50	5 10
September 3	6 3	7 33	4 5	5 25
„ 10	5 46	7 16	4 15	5 35
„ 17	5 31	7 1	4 25	5 45
„ 24	5 15	6 45	4 35	5 55
October 1	5 1	6 31	4 50	6 10
„ 8	4 43	6 13	5 0	6 20
„ 15	4 26	5 56	5 10	6 30
„ 22	4 13	5 43	5 25	6 45
„ 29	3 58	5 28	5 35	6 55
November 5	3 46	5 16	5 50	7 10
„ 12	3 37	5 7	6 0	7 20
„ 19	3 28	4 58	6 10	7 30
„ 26	3 18	4 48	6 25	7 45
December 3	3 13	4 43	6 35	7 55
„ 10	3 10	4 40	6 45	8 5
„ 17	3 10	4 40	6 55	8 15
„ 24	3 13	4 43	7 0	8 20
„ 31	3 19	4 49	7 6	8 25

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